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Individually Figured Optics Schmidt-Newtonian and Schmidt-Cassegrain corrector lenses and mirrors are individually figured to create a superior optical system which is renowned for its exquisite smoothness and performance.

Pyrex® Primary Mirror Premium-grade Pyrex mirrors are used in all Schmidt-Newtonian and Schmidt-Cassegrain optical systems, providing exceptional thermal stability versus competing models using standard plate glass.

Fast F/Ratios Meade's Schmidt-Newtonians have extremely fast, well corrected F/Ratios for short photographic exposure times and wide fields-of-view.

*Excludes Schmidt-Cassegrain. **SC-8 AT requires optional accessory

2" Focuser Aluminum rack and pinion focuser allows the user to achieve a precise focus.*

Eyepiece Holder Accepts both 1.25" & 2" eyepieces. Allows use of all common telescope accessories and cameras.**

8 x 50 Achromatic Viewfinder Easily locate and center deep sky objects (N-6EC model includes 6 x 30 viewfinder).

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Optical Design	Newtonian	Schmidt-Newtonian					Schmidt Cassegrain	Achromatic Refractor		
Model	N-6 EC	SN-6 EC	SN-6 AT	SN-8 EC	SN-8 AT	SN-10 AT	SC-8 AT	AR-5 EC	AR-5 AT	AR-6 AT
Aperture	6" (152mm)	6" (152mm)	6" (152mm)	8" (203mm)	8" (203mm)	10" (254mm)	8" (203mm)	5" (127mm)	5" (127mm)	6" (152mm)
Focal Ratio	f/5	f/5	f/5	f/4	f/4	f/4	f/10	f/9	f/9	f/8
Focal Length	762mm	762mm	762mm	812mm	812mm	1016mm	2000mm	1143mm	1143mm	1219mm
Corrector Lens	N/A	Water White	Water White	Water White	Water White	Water White	Water White	N/A	N/A	N/A
Primary Mirror	Plate Glass	Pyrex®	Pyrex®	Pyrex®	Pyrex®	Pyrex®	Pyrex®	N/A	N/A	N/A
Viewfinder	6 x 30	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50	8 x 50
Hand Controller	Electronic	Electronic	AutoStar #497	Electronic	AutoStar #497	AutoStar #497	AutoStar #497	Electronic	AutoStar #497	AutoStar #497
Price	$469	$639	$799	$799	$949	$1,099	$1,299	$679	$799	$999
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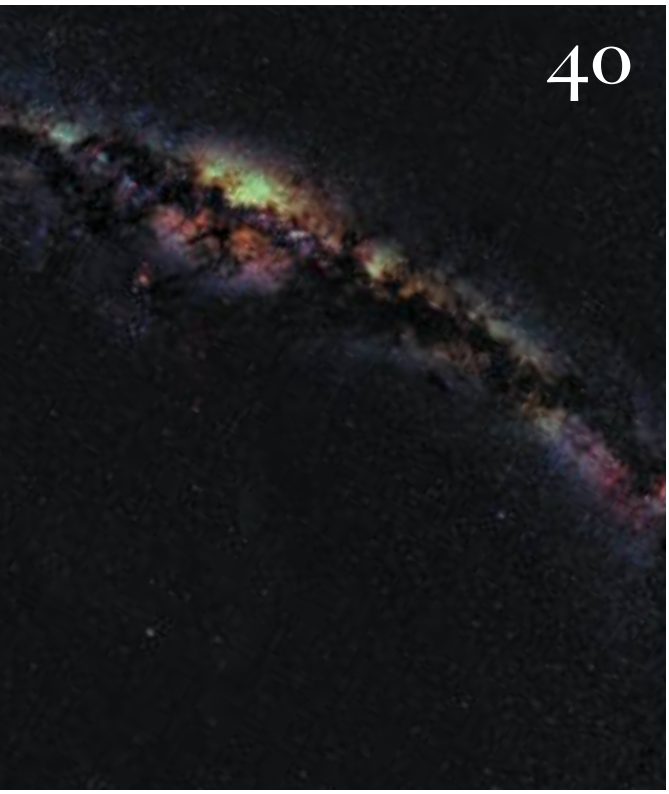

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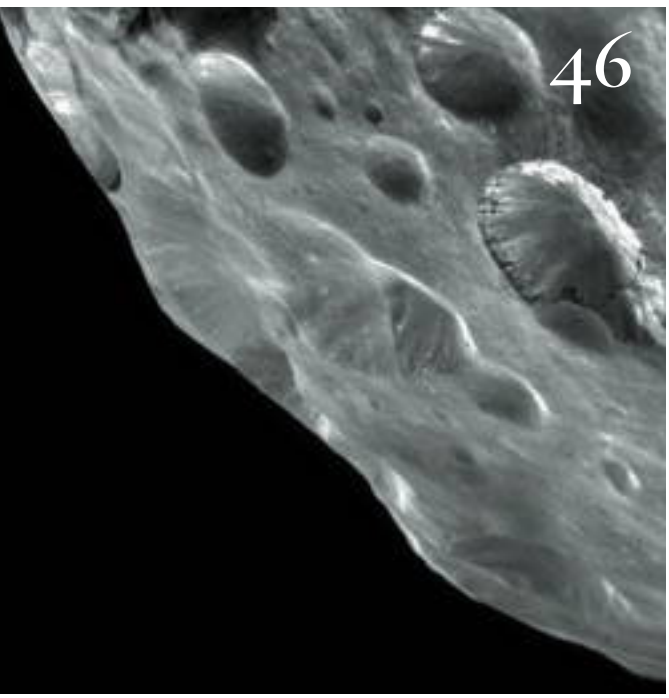

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34 Listening for a whisper
The keys to searching for life elsewhere in the universe are sky coverage and computing speed. The Allen Telescope Array, the latest project from the SETI Institute, has plenty of both — and astronomers are hoping for results in the near future. SETH SHOSTAK

GALACTIC ASTRONOMY
40 Our local star factory
A ring of bright, naked-eye stars called Gould's Belt surrounds the Sun. It's the outcome of a burst of star-making that took place in this part of the Milky Way roughly 30 million years ago. MATTHEW TERRY

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The Cassini spacecraft made its first close approach to a member of the saturnian system this summer, passing within 1,200 miles of the captured moon Phoebe. RICHARD TALCOTT

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Touring the universe's galaxies, nebulae, colorful stars, and beautiful clusters doesn't require a giant telescope. Even a small instrument can show you a lot. IAN RIDPATH

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The Oregon Star Party offers amateur astronomers one of the darkest observing sites in the country. Despite its remote location, visitors still can enjoy a cappuccino and surf the Web while waiting to take a shower. TOM POLAKIS

EQUIPMENT REVIEW
84 Canon 10D digital camera
The era of the digital SLR has arrived, and one camera is leading the way. But is it suited for astrophotography? Find out in this pictorial review. MARK HANSON AND R. A. GREINER

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SETI: What are the chances that life exists elsewhere in the cosmos?

STAR FACTORY: Learn more about Benjamin Gould and his work.

CASSINI: See more fantastic images of the ringed planet and its moons.

DEEP-SKY JOURNAL: Ready for the next step? Challenge yourself to locate fainter objects in the fall sky.

STAR PARTY: Get a veteran observer's advice on what to bring with you.

ON THE COVER
On a distant planet, an advanced civilization thrives elsewhere in the Milky Way. Many astronomers speculate that hundreds or thousands of planets in the universe harbor intelligent life. As our technology improves, the pace of the search quickens and the chance of making contact grows. LYNETTE COOK

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BY DAVID J. EICHER

Check out the new Astronomy.com

Everyone wants to believe that

intelligent civilizations are spread everywhere in the cosmos. This pervasive need not to be alone is what inspires lots of UFO sightings every year — each spotter hopeful that he or she is the first in human history to witness the arrival of beings from another world. And the case for life in the universe is pretty strong. You take 200 billion stars in our galaxy — many or most of which could have planetary systems — and multiply that number by 125 billion galaxies, and you have a helluva lot of places where life could exist.

The search for extraterrestrials (SETI) is the subject of Seth Shostak's story, "Listening for a whisper," on page 34. Shostak, senior astronomer at the SETI Institute in Mountain View, California, argues the pace of SETI research is accelerating. He describes new technologies and techniques such as the Allen Telescope Array — a complex of 350 dishes in development — and optical SETI, which aims toward spotting brief flashes of light. Both will bring the search into a new era.

Closer to home, I am pleased to announce that *Astronomy* magazine's web site, Astronomy.com, has been completely redesigned and re-launched, and we think you'll find it very exciting. Many new features have been added, such as premium on-line content for subscribers and newsstand buyers. This includes customized, interactive star charts, weather reports for your location, space weather alerts for aurora activity, daily access to the SLOOH robotic telescope in the Canary Islands, a massive multimedia gallery of images and videos, a huge archive on the hobby of astronomy, and much more. All this comes free to subscribers and newsstand buyers — a wealth of info to keep you exploring and discovering for years to come.

THE GIZA PYRAMIDS were just one highlight of *Astronomy*'s Egyptian tour. *ASTRONOMY*: DAVE EICHER

See the web box on page 5 for access instructions, and be sure to let us know what you think of the new site. Associate editor Frank Reddy and editorial associate Jeremy McGovern have led the way. Please join me in recognizing Jeremy on his promotion to editorial associate. Congratulations, Jeremy!

I have just returned from Egypt, where I was privileged to see the first transit of Venus since 1882. Check out Reader gallery this month for a taste of the best transit photos.

Yours truly,

Dave Eicher
Editor

Astronomy

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A light issue

"Reclaim the night sky" by Michael E. Bakich (June 2004) was a poignant piece that detailed the sad spectacle of light pollution. Yet it didn't sense a possible remedy of far-reaching implications that may be crouching out in left field. ❨ Night-vision technology presently of military interest may become as available and usable to the public as sunglasses one day. If so, it will profoundly diminish energy consumption in general and nighttime lighting in particular. Who can say what effect having the eyes of a cat would have on the culture of humans?

— JULIUS WROBLEWSKI, VANCOUVER, BRITISH COLUMBIA, CANADA

THE LIGHTS OF CHICAGO, on the shore of Lake Michigan, illuminate the night sky. Increasing light pollution is a problem that many amateur astronomers face around the globe. NASA/IMAGE ISS007-E-16525

The article on worldwide light pollution was informative, but I had to quit reading it due to the eye strain of reading white print on a black background. This was rather ironic, I thought. **— JIM MULHERN,** PARKVILLE, MISSOURI

Lunar junket

James Oberg reported on two lunar missions planned for this year, one a Japanese probe and the other an American package, in "'Maybe' to the Moon this year" (June 2004). The Japanese probe has definite scientific value, but the American "mission" is purely for profit.

A private company called TransOrbital, Inc., has purchased an unused Russian intercontinental ballistic missile (ICBM) that will carry a small scientific package and a probe into lunar orbit. For the first 90 days, the probe will take new images of the Moon. These are neither scientific nor necessary because the Clementine mission surveyed the Moon extensively just a few years ago. The images, however, will provide a thin veneer of authenticity to the whole enterprise.

After 90 days, the probe will be released to crash into the Moon. It will carry photographs, trinkets, jewelry, business cards, and other trash that will be embedded in the Moon's surface upon impact, to remain intact for millions of years. It even will carry cremated human remains — all for the low, low price of $2,500 per gram. That's more than $200,000 per pound. This clearly is a profit-making venture.

There is no international convention that will prevent this demented mission from littering the Moon. Nor, apparently, is there any private sense of propriety involved. It will be justified as yet another American entrepreneurial effort, in keeping with our national spirit of adventure and courage. And profit, of course.

The mission is named Trailblazer, and future astronauts and tourists will remark upon the boldness of the effort and the vision of its perpetrators. We've trashed the Earth — on to the Moon! Standard equipment on all future manned Moon missions should include a pooper-scooper.

— ROBERT SCHMALL, MUKWONAGO, WISCONSIN

Irrefutable evidence

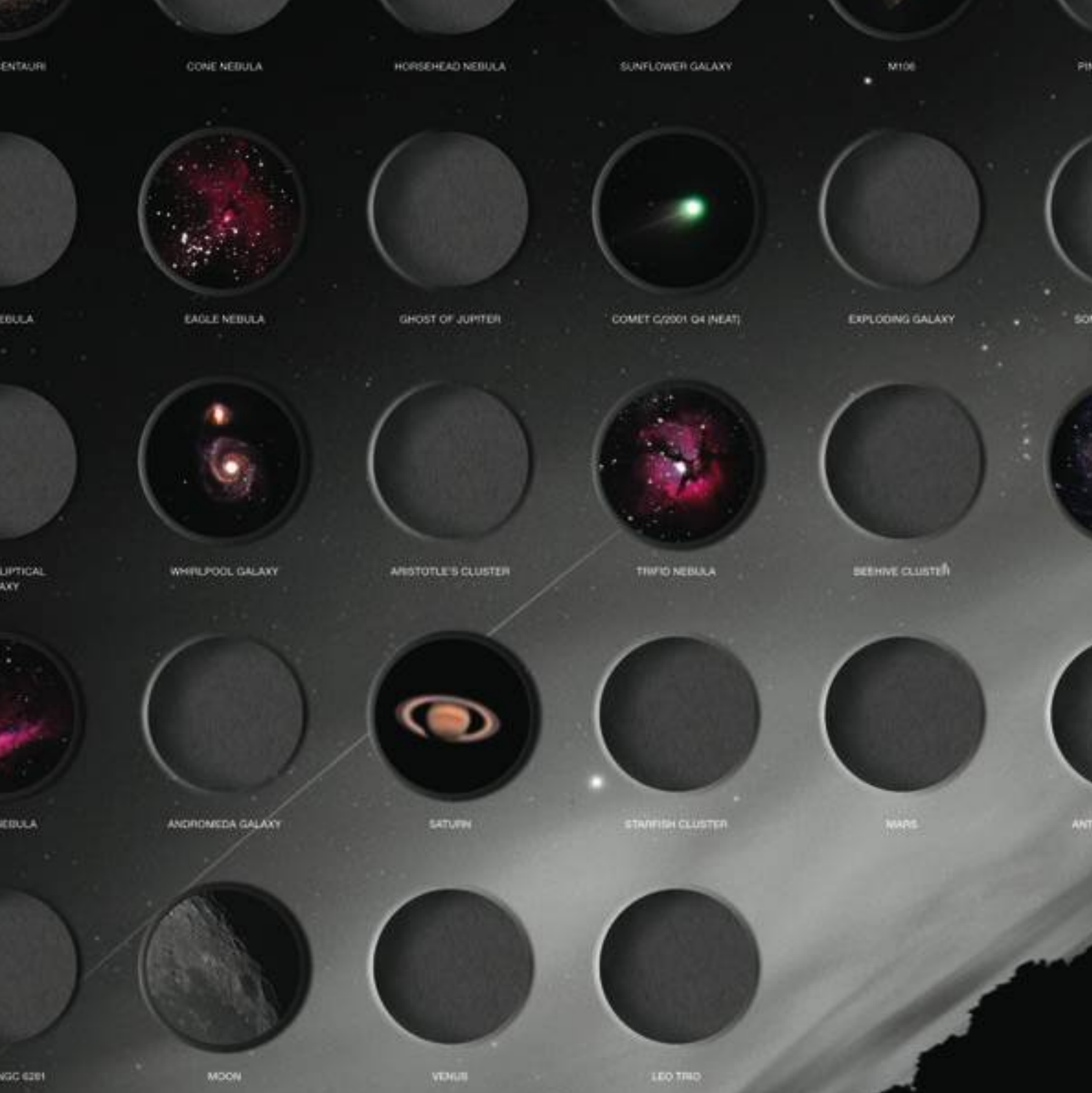
As a reader who is as angered as anybody by these ongoing conspiracy theories — having followed every moment of the Apollo project from its first instigation — I am amazed that none of the "theorists" has ever been challenged in court (See "Did NASA fake the Moon landing?" July 2004).

I wonder if one of the original lunar astronauts, backed up by some organization with fairly deep pockets to defray legal costs, should not take a conspiracy theorist to court for defamation of character. There is no question of the outcome: The evidence would be overwhelming.

A libel settlement of several million or billion dollars against any one of them may quiet the entire lot forever.

— RICHARD McCONNELL, HESSLE, ENGLAND

We welcome your comments. Send letters to Astronomy *Letters, P. O. Box 1612, Waukesha, WI 53187; e-mail to letters@astronomy.com. Please include your name, city, state, and country. Letters may be edited for space and clarity.*



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BY BOB BERMAN

Eye see, you see

Ever show someone a faint galaxy

only to hear them say they couldn't see it? If you're diplomatic, you probably limited your ridicule to a gentle, "Who's your eye doctor, the Marquis de Sade?" There are lots of seriously vision-impaired people among us, and now we can save them from future eye exams. The late summer sky offers a series of great vision tests. You can probe sharpness, faint-vision sensitivity, and even color blindness.

The night sky easily discloses the most common forms of color blindness. One of my friends is red/green colorblind. To him, the striking emerald tint of Uranus is totally absent.

A quick way to spot really bad eyesight is when the person sees the Seven Sisters (Pleiades) as a blur — no individual stars at all. This happens when eyesight is worse than 20/50. If you play quiz-show host and ask most normal-eyed people how many of the Seven Sisters they see, a majority may say "seven" because of the name, but six is almost always the honest number. "Seven" is suspicious because the eighth is the same magnitude as the seventh.

The classic test is Alcor, the companion to Mizar — the second star in the Big Dipper's handle. This "horse and rider," now in the northwest, was the standard eye exam for centuries. Supposedly, the desert Arabs believed only excellent eyes could detect it. But something is screwy with that: Alcor is an easy magnitude 4, and its 700" separation from Mizar gives it the apparent width of an aircraft carrier. Maybe the ancients were all myopic and drove their camels around in circles. But since those desert-dwellers named most of the stars, a more logical explanation is that Alcor has brightened throughout the last few centuries.

A *real* test is Epsilon (ε) Lyrae, the nearest little star to Vega, almost straight up at nightfall. If you have 20/20 vision, it may appear single. With slightly sharper-than-average eyesight, you'll split it in two with the naked eye. My experience is that in a typical group, about one in ten can see it. Teens do better than adults.

Epsilon Lyrae's matching components are separated by 208", or 3.5'. Call it 4' and you've got human vision's usual limit. On the Moon, that figure corresponds to craters about 250 miles wide. Any 7x binoculars or finder scope will let people with normal vision see all craters more than 35 miles wide, like Copernicus (57 miles) and Tycho (54).

What does it take to observe the duplicity in Albireo, everyone's favorite double, high overhead this month? Its unequally bright components are 34" apart and, as we've seen, we have to make them *appear* separated by 208" if they're to match Epsilon Lyrae. That means six times the power. A standard 7x binocular thus reveals Albireo's components to anyone with close to normal vision. Try it.

Only astigmatism remains a problem when using binoculars or a telescope because focusing corrects any myopia or hyperopia automatically.

Faint objects are another story, but you've got to be in a dark setting to explore this issue at all. Even a decent sky shows all four stars of the Little Dipper's bowl and the Milky Way, which is at its best this month. An even darker location reveals its mottled detail and makes the Andromeda Galaxy bright and clear. Let's call that a "good" sky.

Upgrade to a "very good" location and the Hercules globular cluster remains visible, not just winking in and out. Here is where variations in vision show up: Some people won't see it at all because their eyes are too insensitive to faint light.

When you experience "superb" conditions, the constellations virtually vanish because there are so many background stars. In such skies, the winter Milky Way (now in the pre-dawn east) is scarcely inferior to the summer version and dominates the heavens. Orion's "belt" is embedded clearly in a loose star cluster. The Pinwheel Galaxy (M33) looks like a faint Moon-size blob southeast of Andromeda.

Relatively few astronomers have seen M33 with their naked eyes. Observing the Pinwheel Galaxy, therefore, is a major accomplishment, a rewarding goal without using equipment on a moonless September night in an inky-black region. It means your retinas' faint-light sensitivity is A-OK.

Mental health probably can be tested, too, by seeing what patterns you discern in the constellations' random inkblot designs. But let's not go there.

> Maybe the ancient desert Arabs were all myopic and drove their camels around in circles.

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Solar Image by Jack Newton. www.jacknewton.com

BY GLENN CHAPLE

A bright star passes

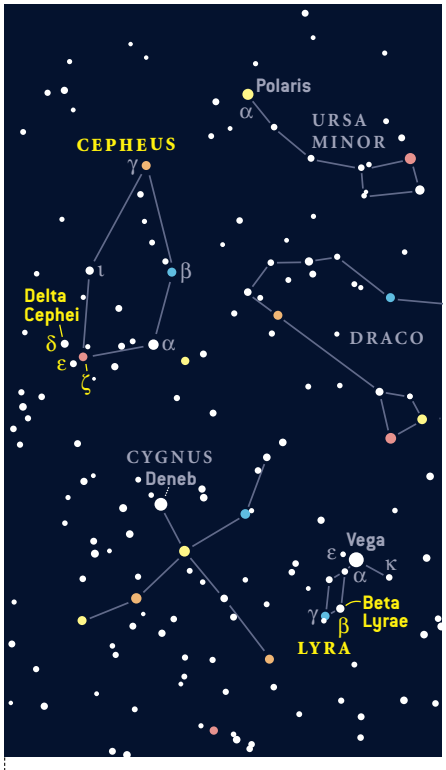
In March, I received the sad news that

Janet Mattei had passed away, a victim of an acute form of leukemia. Janet was the dynamic, inspirational director of the American Association of Variable Star Observers (AAVSO), a role she had held since 1973. She was the AAVSO's shining star. ❮ When I introduced you to R Leonis in April, I noted that my early experiences observing this Mira-type variable inspired me to join the AAVSO. But it was a chance meeting with Janet that sealed the deal.

In the summer of 1979, I was attending the annual Stellafane Convention in Springfield, Vermont. While standing in line at a food stand, I struck up a conversation with the gentleman in front of me. When the topic turned to variable stars, I mentioned how I enjoyed "VSO-ing" (variable star observing) and was considering joining the AAVSO. I felt a tap on my shoulder and turned around. Whether it was coincidence or fate, the person tapping me was Janet Mattei. After brief introductions, she began telling me about the AAVSO and the role its members — mostly amateur astronomers — have in gathering and sharing valuable data on variable stars. Her genuine enthusiasm was infectious. When I returned home, I filled out a membership form and mailed it, along with a check to cover annual dues, to AAVSO headquarters.

As a humble way of honoring Janet's memory, I'd like to figuratively tap you on the shoulder and tell you about the pleasures of VSO-ing. Better yet, let me introduce you to Delta (δ) Cephei and Beta (β) Lyrae — a pair of bright and easy-to-observe variable stars currently visible in our evening sky. If you follow their activity now and throughout the months ahead, you just might find yourself hopelessly addicted to VSO-ing.

In the constellation Cepheus is a triangle made up of the stars Delta, Epsilon (ε), and Zeta (ζ). Delta Cephei, whose variability was discovered by English astronomer John Goodricke in 1784, is the prototype of a class of variable stars known as Cepheids. Like its kindred members, Delta Cephei is a giant star whose light-changes result from internal instabilities. Cepheids typically vary by one or two magnitudes throughout a period of several days or weeks. In Delta Cephei's case, a complete cycle takes 5.366 days. Each cycle begins with Delta Cephei at minimum brightness, magnitude 4.4. In a day and a half, it rises to magnitude 3.5. A steady decline to minimum takes about four days. If you observe Delta Cephei each night for a week, comparing it to Zeta (magnitude 3.6) and Epsilon (magnitude 4.2), you'll capture a complete cycle, and then some.



DELTA (δ) CEPHEI AND BETA (β) LYRAE can be located using this finder chart. Orient yourself by facing north. Tilt your head back so south is at the top of your view. *ASTRONOMY:* ROEN KELLY

Our second variable star is Beta Lyrae, also discovered by Goodricke in 1784. Like Delta Cephei, this star varies with clocklike regularity. But unlike Delta Cep, Beta Lyrae is a variable star *imposter*. Its light-changes have nothing to do with internal irregularities. Beta Lyrae is an eclipsing variable — an extremely close binary star system whose edge-on orbit permits its member stars to eclipse each other periodically. At the beginning of each cycle, Beta Lyrae shines at maximum brightness (magnitude 3.4), similar to its neighbor, Gamma (γ) Lyrae (magnitude 3.3). As the fainter star drifts in front of the brighter one, Beta Lyrae fades to magnitude 4.2 — comparable to Kappa (κ) Lyrae (magnitude 4.3). A slow return to normal is followed by a secondary dip to magnitude 3.9, as the brighter star eclipses the fainter one. A return to maximum brightness completes the 13-day cycle. As with Delta Cephei, you need only make one naked-eye observation each clear night to keep up with Beta Lyrae's antics.

Delta Cephei and Beta Lyrae are fascinating and fun for anyone curious about variable stars. If you explore them, get hooked on VSO-ing, and decide to become a member of the AAVSO, don't thank me. Thank Janet Mattei.

For more information on variable stars, and to learn more about Mattei's contributions to variable star astronomy, check out the AAVSO web site: *www.aavso.org*.

Next month: We pay a visit to a Square and a Circlet. Clear Skies. ▲

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BY WILLIAM SCHOMAKER

Lori Marino

Lori Marino isn't like most of her signal-hunting cohorts who ferret the far reaches of the universe for extraterrestrial intelligence. The Emory University neuroscientist and SETI Institute researcher takes a more inward approach to capture glimpses of ET's brain from Earth. As Marino is fond of noting, few assumptions

about the existence of extraterrestrial intelligence ever have been tested — and she's doing just that.

Brains of the living, the dead, and the fossilized become Marino's laboratories as she probes the outer limits of science. She's digging at the roots of terrestrial intelligence, hoping to discover common evolutionary trends, or what she calls "convergence," which ultimately may render ET more knowable than previously thought. (No animals are harmed in Marino's behavioral studies and all postmortem brains are harvested from animals that have died from non-research causes.)

LORI MARINO searches for extraterrestrial intelligence by expanding our knowledge of intelligent life here on Earth. JACK KEARSE/EMORY UNIV.

Is intelligence common or rare among species on Earth?

In my view, not only is intelligence common, it's ubiquitous. All animals on the planet have the ability to process information and act on it. That is intelligence. Even if we want to restrict the definition of intelligence to something on par with *human* intelligence, we still have to realize that human intelligence did not evolve in a vacuum. It is continuous with all other organisms, down to the neural transmission and neural networking, and it must be understood in that natural context.

How can we hope to identify extraterrestrial intelligence with intelligence on Earth as our only guide?

The common conception is that intelligence has proceeded in a linear fashion, with humans on top and all organisms striving somehow to get smarter. But that idea, which dates back to the time of the ancient Greeks, isn't based on empirical evidence from the record of life on this planet. We need to do more studies to determine just what the patterns of brain evolution are among different species.

In the astrobiological context, what we are trying to do with our cross-species brain studies — between cetaceans (dolphins, whales, and porpoises) and primates (including humans) — is to come to a better understanding of whether there are recurring patterns in brain evolution and whether there are "universal" intelligence principles we might generalize to other planetary ecosystems.

Such work is vital to our understanding of how large, complex brains might evolve under different circumstances and along different evolutionary tracks and yet converge toward similar cognitive abilities or levels of intelligence.

How do you recognize cognitive convergence when you see it?

For example, the neuroarchitecture of the neocortex — the "gray matter" involved in higher levels of cognitive processing — in dolphins is strikingly different from that of other mammals, including primates. Decades of experimental research have shown that dolphins and other cetaceans share a number of very complex cognitive capacities with humans. In 2001, my colleague Diana Reiss and I published the first evidence for mirror self-recognition in dolphins. Self-recognition is a rare capacity in the animal kingdom. It has been demonstrated only in humans and great apes — and now dolphins.

That's one example of cognitive convergence between dolphins and our species.

Are contemporary searches for extraterrestrial intelligence on the right track?

As far as indirect observation of intelligence goes, there is certainly a possibility that searches for intelligent signals buried in the noise of the electromagnetic spectrum will be successful. Of course, this need not depend necessarily on the other party being motivated in the same way humans are, or building telescopes for the same reasons we do.

The ongoing searches for extraterrestrial intelligence conducted by SETI, as well as by similar projects around the world, are extremely worthwhile because the payoff is potentially enormous. Some of the most technically and scientifically innovative people I know are doing such work.

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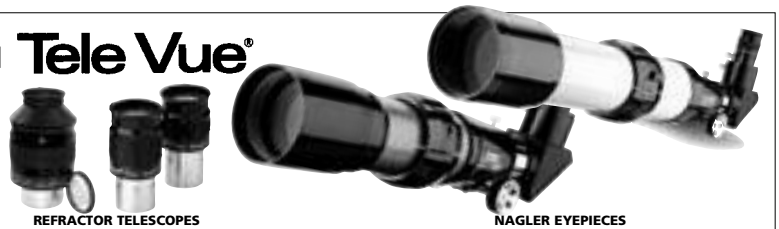

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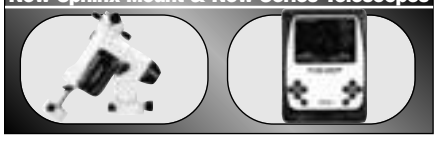

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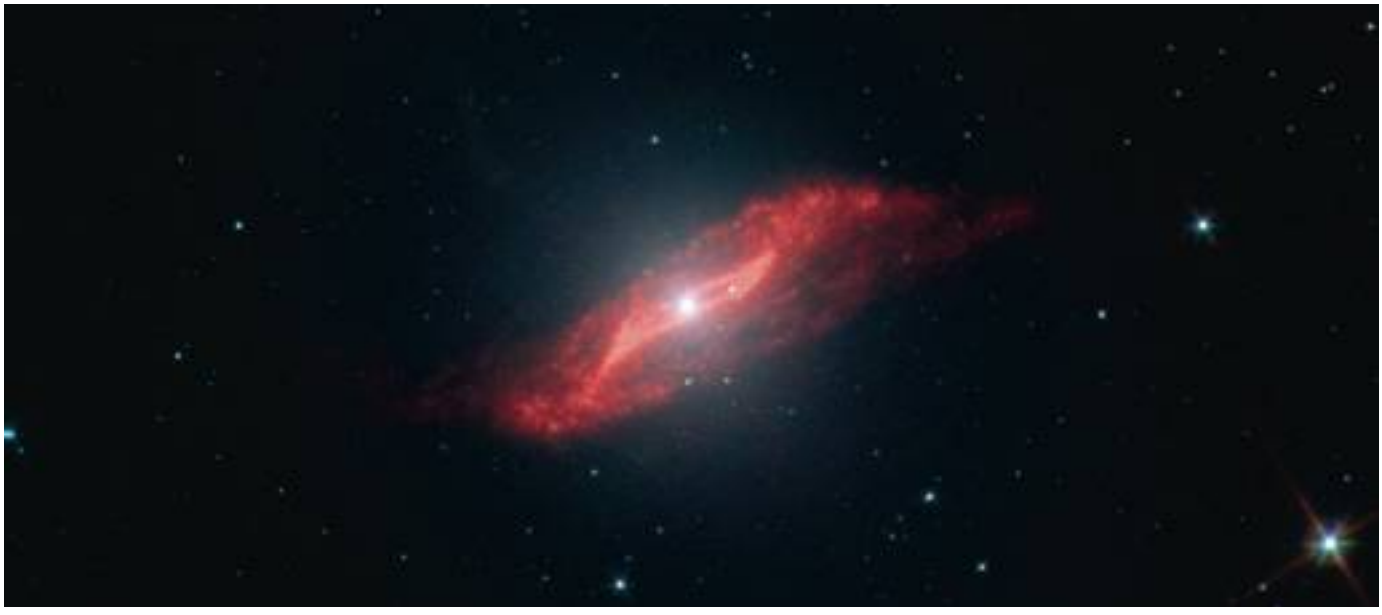

FILMY AS A SHEET OF GAUZE, dust from a former spiral galaxy makes a crumpled parallelogram in the heart of giant galaxy Centaurus A. NASA/JPL/CALTECH, J. KEENE

24 Finding more proto-stars than expected

24 Where spacecraft let it all hang out

26 Spitzer finds the youngest planet

28 Rotten rocks on Mars

EXTRAGALACTIC ASTRONOMY

Centaurus A eats galaxies for snack food

The dusty remnant of a spiral galaxy's disk lies twisted in the center of the giant elliptical galaxy Centaurus A (NGC 5128). The dusty disk was found by a group of astronomers led by Jocelyn Keene (Jet Propulsion Laboratory) who used the infrared-sensing Spitzer Space Telescope.

Spitzer's Infrared Array Camera (IRAC) looked past the galaxy's visible parts to spot the twisted sheet of dust deep inside.

"IRAC can look right into and even through Cen A," says Keene. This ability let the group image the dust, which resembles a bent parallelogram. Its appearance gave the team the clues they needed to model how gas dynamics and tidal forces molded its shape.

The likely source for the dust is a spiral galaxy that drifted into Cen A's gravitational grip, "about 200 million years ago," says Keene.

She suggests the spiral galaxy's older stars have been grafted onto the outer parts of Cen A, while the dust in its disk sank into the center of the big galaxy. In the end, the spiral's leftovers will be absorbed by Cen A, a story that has probably happened many times over. — **ROBERT BURNHAM**

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STELLAR ASTRONOMY

Unexpected worlds

MANY MORE STARS than expected — and lots of icy, organic materials — greeted astronomers using the Spitzer Space Telescope to peer into RCW 49, a star-forming region 13,700 light-years away. NASA/JPL/CALTECH/U. WIS., E. CHURCHWELL

The dark dust clouds surrounding a prolific stellar nursery known as RCW 49 have been swept aside — metaphorically, anyway — by NASA's Spitzer Space Telescope. Spitzer sees in the infrared, allowing it to peer through the dust clouds that normally hide such regions.

What Spitzer saw — more than 300 previously undetected protostars — surprised scientists who weren't expecting to see nearly so many.

"It knocked our socks off," says Ed Churchwell (University of Wisconsin), a principal investigator in the Galactic Legacy Infrared Mid-Plane Survey Extraordinaire project, or GLIMPSE.

Before ending in November, GLIMPSE will survey roughly two-thirds of the Milky Way to help scientists understand the structure of the inner galaxy and its star formation. RCW 49, which lies about 13,700 light-years away in the constellation Centaurus, was an early target for GLIMPSE. Astronomers think the discoveries made in this nebula form just the tip of the Spitzer iceberg. **— PAMELA ZERBINOS**

The place in space to hang out

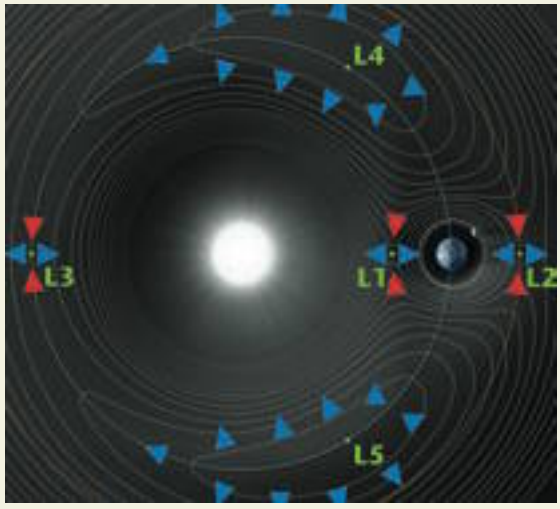
The planning for future space astronomy missions is raising interest in a region of space that may someday become a gateway for expeditions far beyond Earth.

NASA's James Webb Space Telescope will not be deployed in low Earth orbit (LEO). Instead, planners are looking at the Sun-Earth Lagrange point number 2, or SEL2. It lies about a million miles out from Earth, directly away from the Sun. At SEL2, four times farther than the Moon, the gravity of Sun and Earth combine to produce a relatively stable gravity field.

A telescope placed there has a nearly unrestricted view of the celestial sphere. It experiences benign thermal conditions (no rapid day–night cycles), and the uniform gravity lets a widely scattered fleet of spacecraft maintain highly precise relative positioning.

But SEL2 is worth more than just a parking lot. In a recent report from the International Academy of Astronautics called *The Next Steps in Exploring Deep Space*, SEL2 is pinpointed as key to exploring interplanetary space.

Former NASA chief scientist Wesley Huntress told Congress in late 2003 that the study "envisions the establishment of a permanent human presence in space using an evolutionary approach to the development of space transportation infrastructure utilizing well-defined intermediate destinations as stepping-stones to Mars."



LIKE A VALLEY IN SPACE, the second Sun-Earth Lagrange point (L2 at right), offers a relatively stable point for spacecraft — and it provides a gateway to deep space. NASA/WMAP SCIENCE TEAM

SEL2 is the first of these intermediate destinations. Human missions would take about 15 days to get there, and it would be almost as easy in terms of rocket power as the Apollo 8 lunar orbit mission of Christmas 1968.

The crew vehicle could service a number of astronomical instruments at SEL2, observe Earth's atmosphere as Earth creates an annular eclipse of the Sun, and test equipment designed for interplanetary flight.

When the time comes to build a vehicle to go beyond the Earth-Moon system, it could be assembled at SEL2. This would require more initial rocket power than reaching low Earth orbit, but the propulsion could be obtained economically from reusable "space tugs," and the energy to get to that point in space then could be recouped on departure from Earth. Targets such as asteroids, or even brief flybys of Mars, could be achieved by vehicles based at SEL2.

This region — call it the gateway — has been identified already as a place where astronomical instruments will be deployed, so we have multiple reasons to want to gain access to it.

It's curious, but just as it has in centuries past, the new astronomy of tomorrow will point the way for exploring space. **— JAMES OBERG**

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- **7-element optical design**
- **70° EXTRA WIDE** field of view (except 50mm)
- Fully multi-coated

1-1/4"
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#93358 - 19mm $149.00
#93359 - 23mm $179.00

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#93364 - 40mm $289.00
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- Five-element guiding eyepiece
- Reticle pattern is a .0075" double spaced line system
- Multi-coated optics for increased contrast
- Long eye relief
- High power is ideal for guiding
- 50° apparent field of view
- Optional illuminator is required ($39)

#94169 10mm Plössl Reticle Eyepiece —1-1/4" $124.00

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- Five Superior Grade Plössl Eyepieces — 1.25"; Barlow Lens — 2x 1.25"
- Six Colored Eyepiece (Planetary) Filters; Moon Filter — 1.25"
- Aluminum Carrying Case

#94303 - Filter & Eyepiece Kit $149.00

Ultima® 2x Barlow —1¼"

- **Three-element apochromatic design**
- 27mm clear aperture
- Fully multi-coated

#93506 - 1-1/4"Ultima Barlow $79.00

Microguide Eyepiece —1¼"

- Laser-etched reticle with built-in, battery illuminator
- Multi-coated 12.5mm Abbe (4-element) Orthoscopic
- Direct guiding on stars outside the center of the field of view
- Greatly improved off-axis guiding to capture much fainter, sharply focused guide stars without reducing limiting magnitude
- Measure position angles and separation of double stars

#94171 - Microguide Eyepiece 1-1/4" $194.00

Erect Image Diagonal —1¼"-90°

•Amici prism design allows you to view sky objects at a comfortable 90° and view land objects oriented properly, meaning the image is upright and correct from left to right.

#94108 - Erect Image Diagonal —1-1/4"-90° $39.00

Erect Image Diagonal —NX4

•Amici prism design allows you to look into your NexStar 4 at a 45° angle, and view land objects oriented properly, meaning the image is upright and correct from left to right.

#94116 - Erect Image Diagonal —NX4 . . . . . $29.00

Radial Guider

- Use with Schmidt-Cassegrain telescopes in prime focus, deep-sky imaging or astrophotography
- Simultaneously photograph and guide through the optical tube assembly of the telescope
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- Eliminates the problem of differential flexure

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- Works with all Celestron C5, C8, C9-1/4 , C11 and C14 telescopes
- Minimizes coma and flattens field of view for pinpoint off-axis stars
- Reduces exposure times by 60% and increases field of view
- f/6.3 for C5, C8, C91/4 and C11 telescopes and f/7 for the C14 telescope

#94175 - Reducer/Corrector $139.00

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- 2" 90° Mirror Diagonal to thread on Schmidt-Cassegrain telescopes
- Includes an adapter to use with refractor telescopes
- Includes an adapter to accept 1-1/4" eyepieces
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- Smooth mechanics that are precision manufactured for reliability

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Extherm Reusable Hand Warmer NEW!

- Perfect for chilly evenings outdoors, camping, stargazing, or at sporting events
- Convenient, reusable, and made from nontoxic materials
- Heat lasts up to 1 hour

93504 - Extherm Reusable Hand Warmer $10.00

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GPS Accessory CN16

- Use the power and accuracy of GPS satellites to align your telescope with the optional CN-16 GPS Accessory. Plug the GPS receiver module into your telescope to link up and automatically download information from one of many global positioning satellites
- Kits include CN16 and installation components

#93966 - CN-16 kit for Advanced GT $269.00
#93963 - CN-16 kit for NexStar "i" Series $229.00
#93967 - CN-16 kit for CGE Series $249.00

Vibration Suppression Pads

- Reduces vibration time by almost 100% and decreases vibration amplitude
- The pads fit between the bottom of the tripod legs and the ground

#93503 - Vibration Suppression Pads (3) $59.00

Contrast - Booster Filter —1¼"

by Baader

- Eliminates color aberration inherent inachromatic refractor telescopes
- Eliminates the blue hue around lunar and planetary subjects
- Multi-layer coatings for 95% transmission

#94121 - 1-1/4" Contrast-Booster Filter $49.00

Model A — for 1-1/4" eyepieces

Model B — for back threads of SC's

LPR (Light Pollution Reduction) Filters

- Made of high quality, flat polished optical glass
- Over 40 layers of coating
- Broadband anti-reflection coating prevents ghosting and improves contrast

#94126A - LPR Filter Model A—1-1/4" $69.00
#94127A - LPR Filter Model B $99.00

1¼" Polarizing Filter Set

- Transmits only light moving along a specific plane; increases contrast between surfaces with different planar transmissions
- Polarization effect makes blue skies a deeper blue, eliminates surface reflections and helps reduce atmospheric haze

#93608 - 1-1/4" Polarizing Filter Set $29.00

Eyepiece Filter Sets —1¼"

- An invaluable aid in planetary and lunar observing
- Reduces glare and light scattering
- Increase contrast, definition and resolution
- Lessens eye fatigue

#94119-10 (21, 80A, 15, Polarizing) $44.00
#94119-20 (12, 25, 56, ND-25) $44.00
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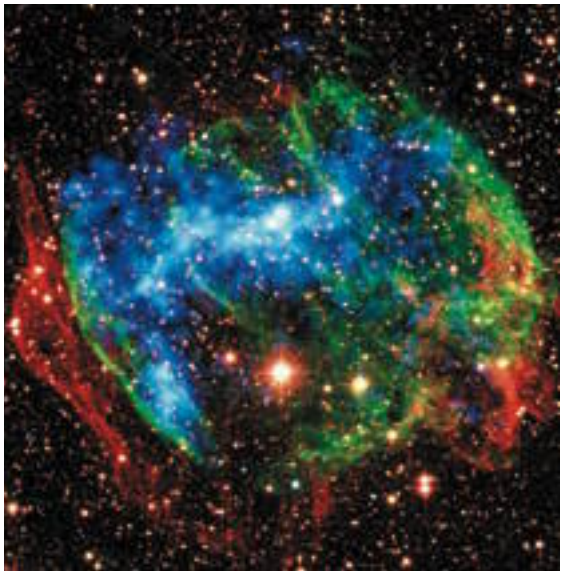
THE MASS OF A BROWN DWARF has been measured for the first time using observations of its orbit. The brown dwarf has a mass of 0.066 solar mass or about 70 Jupiters; its primary star weighs 0.085 solar mass.

HIGH-ENERGY ASTROPHYSICS

Have astronomers found a local gamma-ray burst?



BLUE COLORS trace X-ray emission from iron and nickel in the supernova remnant W49B. This supernova may have been the nearest known gamma-ray burst. NASA/CXC/SSC/J. KEOHANE

Did a relatively nearby supernova produce a gamma-ray burst (GRB)? Astronomer John Keohane (Jet Propulsion Laboratory) thinks so and has images and data from two telescopes — the orbiting Chandra X-ray Observatory and the Palomar 200-inch telescope in California — to support his argument.

Using these instruments, Keohane observed a known supernova remnant, W49B, and found several infrared-bright rings plus intense X-ray emission from iron and nickel in jets that align with the remnant's axis. For Keohane, the tipoff that W49B wasn't an ordinary supernova lay in two pieces of evidence: the lack of a neutron star (pulsar) at the remnant's core and the iron and nickel X-ray emission.

"These indicate," he says, "that an extremely massive star exploded, sending out two oppositely directed jets rich in iron. This makes W49B a prime candidate for being the remnant of a gamma-ray burst that ended as a black hole."

Gamma-ray bursts shoot tightly directed beams of very high energy that are visible across the universe. The nearest known GRB is several million light-years away, well beyond the Milky Way. W49B lies about 35,000 light-years away, so as these things go, it certainly counts as close. — **R. B.**

STELLAR ASTRONOMY

Spitzer finds youngest planet

Astronomers using the Spitzer Space Telescope have identified the youngest planet so far known, with an estimated age of a million years or less.

Dan Watson and William Forrest (Univ. of Rochester) observed Cohen-Kuhi Taurus 4, or CoKu Tau 4, with Spitzer's InfraRed Spectrograph (IRS).

Unlike other protoplanetary disks they have observed, CoKu Tau 4's disk has a hole around the star where a newborn planet has swept up the debris left from the star's formation. Because the star is only about a million years old, this is the upper age for the planet. — R. B.

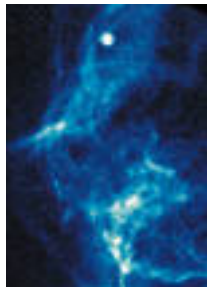
A NEW PLANET only a million years old orbi a young star in Taurus. NASA/JPL/CALTECH ARTWORK

SUPERNOVAE

FUSE pierces the Veil

The Veil Nebula is part of the Cygnus Loop, a supernova remnant some 5 to 8 thousand years old. However, astronomers have not been able to determine its basic properties, such as distance, size, etc.

Recently, a team of astronomers led by William Blair (Johns Hopkins University) used the Far Ultraviolet Spectroscopic Explorer satellite (FUSE) to measure the distance to an ultraviolet-bright star that appeared to lie behind the Veil. The team confirmed that the Veil does indeed lie in front of the star, which is 1,860 light-years away.



FINDING A STAR (top) behind the Veil Nebula will help scientists clarify the nebula's size and age. JHU, W. BLAIR

This result will help nail down the Veil's expansion rate, age, energy, and so on. — **P. Z.**

PLANETARY GEOLOGY

Martian "blueberries" in Utah

Geologists at the University of Utah announced that concretions in the widespread Navajo Sandstone formation resemble the hematite-rich "blueberries" discovered on Mars in Meridiani Planum.

Writing in *Nature* (June 17, 2004), team leader Marjorie Chan says, "We came up with the recipe for [martian] blueberries based on our study of hematite-rich areas of southern Utah."

"Blueberries" is the whimsical name given to the BB-size spheres that cover the surface of Meridiani Planum, where the Mars rover Opportunity landed. The Utah concretions are larger and precipitated when mineral-laden water flowed through the sandstone, about 25 million years ago. — **R. B.**

DRIFTS OF "BERRIES" erode from the sandstone they formed within. They are often available in southwestern rock shops as "moqui marbles." UNIV. UTAH, B. BEITLER

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WHAT'S IN A NAME?

Here's a quick guide to identifying the various types of Celestron Advanced Series telescopes:

S = Schmidt-Cassegrain
N = Newtonian
R = Refractor
GT = Computerized GoTo
HD = Heavy Duty
CG-4 Mount

Example: C10-NGT
10" Newtonian on a computerized mount.

CG-5 Mount — Precision engineered for stability.

Our **CG-5 German Equatorial Mount** has precision worm gears on both axes for extremely smooth tracking and slewing and uses a large shaft and bearings and substantial base castings for additional stability. A **new heavy-duty tripod** with **larger and more substantial legs** provides excellent damping characteristics for more stable views. There is a convenient **latitude scale** for easier alignment and an **optional polar finder scope** for the ultimate in precision alignments. The **C4 R** and **C6 N** both come with our rugged CG-4 mount.

Advanced GT's — GoTo convenience for precision accuracy.

Advanced Series GT's feature a computerized GoTo version of our heavy-duty CG-5 mount. Couple this solid mount with the included NexStar® computer control system and utilize many of the same features as Celestron's most advanced GoTo telescopes with a database of over 40,000 celestial objects!

Upgrade to GPS.

Optional CN16 GPS Accessory Kit (#93966).

C9 1/4-SGT (#11046)

Advanced GoTo models can also be upgraded to GPS with the optional **CN16 GPS Accessory Kit (#93966).** It contains the CN16 GPS module, bracket and holder, and Auxiliary Port Module.

C10-NGT (#11048)

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NeXRemote™
Remote Control Software

Celestron's new optional NexRemote remote control software allows alignment and operation of Advanced Series GT telescopes from a PC or laptop. For more information about Celestron's new NexRemote software, visit **www.celestron.com**.

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C10-NGT (#11048): $1,199 + $95 S&H; C10-N (#11047):$909 + $75 S&H; C9 1/4-SGT (#11046): $1,779 + $105 S&H; C9 1/4-S (#11045): $1,469 + $85 S&H; C8-SGT (#11026): $1,359 + $75 S&H; C8-S (#11025): $1059 + $85 S&H; C8-NGT (#31062): $1019 + $85 S&H; C8-N (#31061): $699 + $65 S&H; C6-RGT (#21020): $1069 + $95 S&H; C6-R (#21019): $849 + $75 S&H; C6-N (#31056) $399 +$50 S&H; C6-N HD (#31053): $529 + $50 S&H; C6-NGT (#31054): $799 + $70 S&H; C5-SGT (#11072): $1,099 + $75 S&H; C5-S (#11071): $849 + $65 S&H; C4-R (#21016): $399 + $40 S&H

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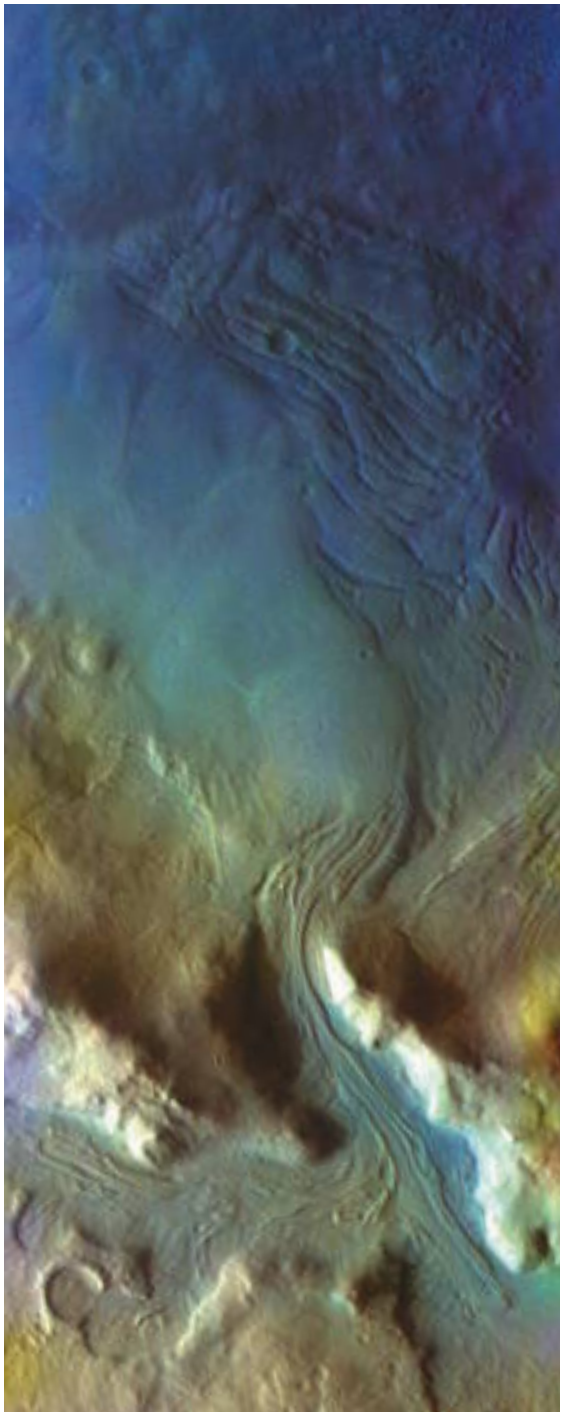
THE GEOLOGIC HISTORY OF THE MOON, a landmark book by Don Wilhelms was published in 1987 by the U.S. Geological Survey and is long out of print. It is now available as scanned PDF chapters at cps.earth.northwestern.edu/GHM.

Moreux Crater debris flow



MATERIAL FLOWED from the rim of Moreux Crater (bottom of frame) north down onto the crater floor. This false-color Mars Odyssey THEMIS image was taken near 41° north and 316° east. The bluish area at top seems to be a thin, active sand sheet; dunes appear at top right. The warm-tone areas in the south are mantled by dust. NASA/JPL/ASU/IMAGE 20040527A

GALACTIC ASTRONOMY

Stripping a spiral

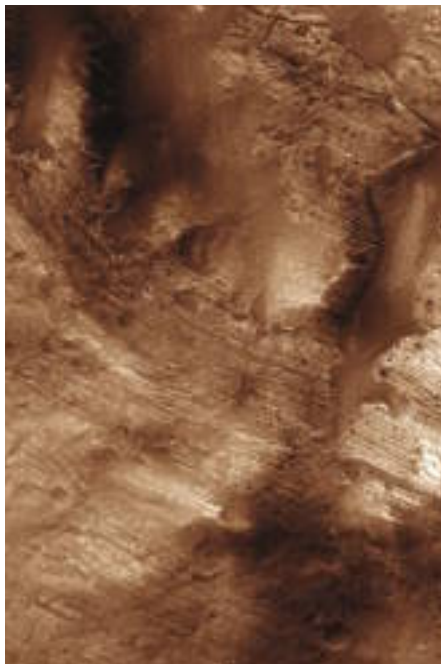
Spiral galaxy NGC 4402 shows striking evidence of being stripped bare of its star-forming material. NGC 4402 lies about 50 million light-years away and is moving toward the center of the Virgo galaxy cluster.

There it meets a hot "wind" of the cluster gas, which can reach millions of degrees. The wind strips away most of the galaxy's gas and dust, taking with it much of its star-forming ability.

"The image shows galactic disruption on a grand scale," says Hugh Crowl (Yale University), who did the research. "It gives us confidence that this widely postulated process plays a significant role in the evolution of galaxy clusters." — P. Z.

NGC 4402 is being stripped of star-making material by the Virgo cluster. NOAO/AURA/NSF/H. CROWL

MARS PHOTOJOURNAL



STEEPLY DIPPING ROCK LAYERS in the central peak of Oudemans Crater tell of the impact that made the crater, which lies near Noctis Labyrinthus. The banded, light-tone rock, perhaps sedimentary in type, was tilted almost vertical by the impact. The image, sunlit from the upper left, is 1.9 miles (3 km) across. NASA/JPL/MSSS/IMAGE R15-01588

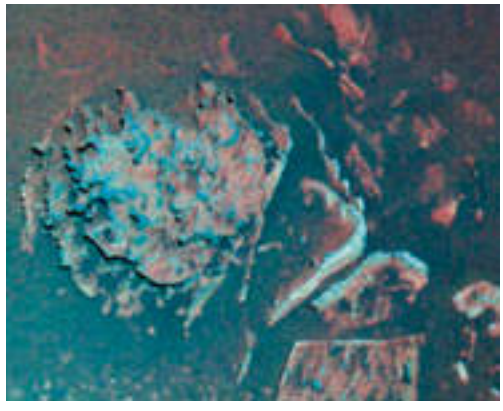
PLANETARY SCIENCE

Pot of Gold: Mars mystery rock

Spirit, the Mars rover in Gusev Crater, is at the Columbia Hills, where it has found a scientific mystery in a 4-inch rock scientists call Pot of Gold.

"This is a remarkably strange-looking rock," says rover lead scientist Steve Squyres (Cornell Univ.). "It has thin, flat planes cutting through and it has these nuggets on the ends of stalks." He says Pot of Gold contains hematite, but it may not have formed by the action of water, the usual method.

As to the origin of the mysterious nodules, Squyres says, "I don't know *how* these formed, and it's driving me nuts!" — **R. B.**



NODULES ON STALKS at Pot of Gold are unlike anything yet seen on Mars — or Earth. NASA/JPL/CORNELL

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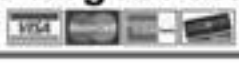
We Accept  Telescopes, Accessories & much more!

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The MaxView-DSLR is for you!

DSLR II shown on a Canon 10D"

NEW! Hot Product!

Finally a variable projection adapter large enough to hold ANY eyepiece! Now you can use your best eyepieces for astrophotography. The picture at right shows the 1.25" version (left), the 2" version (right) and a standard sized projection adapter between them for scale. The 1.25" version will accept any 1.25" eyepiece. The 2" version will accept any 1.25" or 2" eyepiece...yes even a 31mm Nagler! Both versions include a removable MaxPower lens to increase magnification and allow use in scopes with very little back focus. These are variable length adapters allowing you to adjust the magnification in small increments to fill the frame. Change eyepieces in seconds. Machined from solid aluminum, anodized black with a knurled grip ring. 2" version includes 1.25" adapter. Both units are T threaded for use with standard T-Rings. Can be used with 35mm SLR cameras too! *Camera not included.

1.25" MaxView-DSLR 2.00"

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MaxView™ & MaxPower™ Lenses

Our award winning MaxView 40 and new MaxView II Digital Camera Adapters are specially designed eyepieces for use with digital cameras. Designed to give the least vignetting, even when used with large lensed cameras. The MaxView 40 is 1.25" format while the MaxView II is 2" format. We carry dozens of adapter kits to fit either MaxView to most all digital cameras with threaded lenses. Our new MaxPower™ lenses thread into the bottom of the MaxView eyepieces to increase magnification by 60% while maintaining the desirable properties of the MaxView eyepieces. We also have versions made specifically for use with Microscopes and most popular nature scopes such as Swarovski, Pentax, Leica, Zeiss and more! **Patent Pending.**

New 2" MaxView II!

1.25" MaxView 40

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MaxPower 2™ 2.0" 69.00

Awarded "Hot Product" SKY & Telescope Magazine 2003

MaxPower Boosters!

The Digi-T™ System

The world's best selling Digicam Adapter!

*Patent Pending

The Digi-T system allows you to use most popular plossl eyepieces with your digital camera. We have dozens of kits to fit all popular digital cameras. *See complete details on our website.*

Pricing from $59.95 to $109.95

Fits: Meade Super Plossls, Celestron NexStar Plossls, ScopeTronix ST Series, Orion Sirius Plossls, and many more eyepieces with removable rubber eyeguards.

Add GPS to your Scope!

Easy to install unit adds GPS functionality to many scopes. Versions to work with Meade ETX, LX90, LX200 (GPS and Classic), Losmandy Gemini, and Astro-Physics GTO. No more entering the time, date, and location! It is all entered for you at very high accuracy! See our website for full details and model number for your particular telescope.

STARGPS $169.00

WebCam Adapters

All adapters fit 1.25" focusers

We carry adapters to attach most popular webcams and "C" mount security cameras to your telescope. See our website for your specific camera models.

STWCA1 Fits Toucam,Creative WC Pro, more **29.95**
STWCA2 Fits QuickCam, 3com and more **29.95**
STWCA3 Fits Vestra Pro, Kensington, more..... **29.95**
STC125 Fits all "C" Mount cameras..... **22.95**

Wide Angle Eyepiece & Digital Camera Adapter for Nikon 950/990/995/4500

These 1-1/4" Wide Angle 60+ degree Apparent Field View eyepieces can also be used as a fine visual eyepiece, but unthread the eyeguard to reveal a 28mm threaded adapter that allows it to be mounted to any digital camera with a 28mm lens thread! A 28 to 37mm adapter is also available.

STWA14 14mm... 109.00 | STWA18 18mm... 99.00

The ScopeTronix EZ-PIX™ Universal Digital Camera Adapter

No lens thread on your digital camera? No problem! Our universal design fits any camera with a standard 1/4-20 threaded mounting hole. The padded eyepiece clamp slips over most Plössl eyepieces and barlow lens. The EZ-PIX is the original universal camera adapter, don't be fooled be cheap imitations that claim to be of an improved design. *The EZ-PIX is still the best design available!* Spacer included (shown at right)

Now includes two padded clamps to fit a wide variety of eyepieces!

STEZPIX Universal Digital Camera Adapter..... **49.95**

NEW Product!

4 in 1 Multi-Mate Alignment Tool

The ScopeTronix Multi-Mate is four handy devices in one compact inexpensive unit. Great for GOTO scope setup. Insert it into your eyepiece holder and use the bubble level to quickly and accurately level your optical tube. Flip it over and use the handy compass to quickly find North. When your scope is in storage it acts as a dust plug and in addition it contains a replaceable bag of desiccant to protect your scope in storage. The desiccant draws moisture out of your OTA through small holes around the compass and traps it in the desiccant chamber. This helps prevent optical damage due to moisture and mold formation. **STMM** 4 in 1 Multi-Mate... **$24.95**

CrystalVue Optics Sharp Shooter 8x32mm Monocular and Telephoto Digital Camera Lens

8x32mm monocular converts to a telephoto lens for digital cameras. Remove the rubber eyeguard to reveal a 37mm lens thread. Includes a 28mm to 37mm adapter ring. **CVOSS**..... **149.00**

(Shown with Coolpix 995)

ScopeTronix Thread On Solar Filters for ETX & Tele Vue scopes

Custom machined black aluminum filter cell securely threads onto telescope

STSF60	fits ETX60 and ETX70	**64.95**
STSF90	fits ETX 90	**84.95**
STSF105	fits ETX 105	**94.95**
STSF125	fits ETX 125	**99.95**
STSF76	fits Tele Vue 76 ...NEW!	**79.95**
STSF85	fits Tele Vue 85 ...NEW!	**89.95**
STSFB	fits Canon 50mm IS(2)	**99.95**

ScopeTronix ST Series Plössl Eyepieces

STPL04	4mm ST Series Plössl	**37.95**
STPL06	6mm ST Series Plössl	**37.95**
STPL09	9mm ST Series Plössl	**37.95**
STPL12	12mm ST Series Plössl	**37.95**
STPL15	15mm ST Series Plössl	**37.95**
STPL20	20mm ST Series Plössl	**37.95**
STPL25	25mm ST Series Plössl	**37.95**
STPL32	32mm ST Series Plössl	**42.95**
STPL40	40mm ST Series Plössl	**42.95**
STPLSET	Complete Set (9)	**349.00**

ScopeTronix Barlow Lenses

STBAR2	2x	**39.95**
STBAR3	3x	**42.95**
ST2BAR2	2x 2"	**79.95**

ScopeTronix Eyepiece Bottles & Filter Cases

We now stock 6 different size eyepiece bottles to fit almost any size eyepiece!

ScopeTronix "Bolt-Style" Eyepiece Bottles

STEP01	Eyepiece Bottle - 1.4" ID, 1.9-2.6" Length	**3.00**
STEP02	Eyepiece Bottle - 1.6" ID, 3.2-4.7" Length	**3.00**
STEP03	Eyepiece Bottle - 2.0" ID, 3.2-4.7" Length	**4.00**
STEP04	Eyepiece Bottle - 2.0" ID, 3.2-4.7" Length	**5.00**
STEP05	Eyepiece Bottle - 2.5" ID, 4.7-7.8" Length	**6.00**
STEP06	Eyepiece Bottle - 3.1" ID, 4.7-7.0" Length	**7.00**

ScopeTronix Filter Cases

STBOXS	Small (1-1/4" filter size box)	**1.95**
STBOXL	Large (reducer/corrector size box)	**2.95**

Color Filter Set For 1.25" Eyepieces

$37.95

4 piece set includes Red #23A Yellow #12 Blue #80A Green #58A

Parfocal Rings

Make your EP's parfocal!

1.25" STPRING 7.95
2.0" STPRING2 8.95

ScopeTronix ETX & NexStar Piggy Back Camera Mounts

STPB70	ETX-60/70AT	**42.95**
STPB90	ETX-90EC/RA	**49.95**
STPB125	ETX-125EC	**64.95**
STPBN5	NexStar 5	**59.95**

1.25" Extension

STEPEXT 12.95

Extends 1.25" EP barrel by 1 inch. Threaded for filters or stacking.

ScopeTronix Tripod Adapter & Accessory Holder for ETX

Deluxe Tripod Adapter

Fits ¼" & 3/8" tripods. Holds Autostar & 4 Eyepieces **STDXTRAD 96.95**

Accessory Tray for ETX

STTRAY90	ETX90	**59.95**
STTRAY105	ETX105	**59.95**
STTRAY125	ETX125	**64.95**

Accessory Tray mounted to ETX

ScopeTronix Flexi-Focus™ for ETX Telescopes

Oversized knob and flexible shaft allow crisp, sharp focusing even when OTA is pointed straight up!

STFLEX70 For ETX-60/70AT. **34.95**
STFLEX90 For ETX-90EC/RA **34.95**
STFLEX125 For ETX-125EC.. **34.95**

Flexible shaft reduces vibrations. Achieve sharp focus fast!

ScopeTronix Green Laser Pointer

5mw continuous mode laser beam is easily visible at night! 2 AAA batteries included.

STGREEN 5mw Green Laser Pointer **$189.00**

NEW! ScopeTronix Tripod Bag for LX Tripods

Our quality tripod bags are designed for the Meade field tripod used with the LX series scopes up to 10" such as the LX10/50/90/200/GPS. Features include full interior padding, heavy duty carry handles, an adjustable shoulder strap, color keyed to match the Meade soft case, and an outside pocket sized just right for a set of vibration suppression pads!

STBAGLX LX tripod bag **79.00**

ScopeTronix designs and manufactures many unique products like the patent pending Maxview's, Digi-T, Flexi-Focus, etc... Dealer inquiries are always welcome!

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Hundreds more products online!
telescope.com

SkyQuest™ XT IntelliScope™ Dobs

They're the newest, most advanced Dobsonians on the market, featuring sleek, lighter-weight bases for easier portability; a new adjustable, springless CorrecTension friction control system; plus larger, 5.75"-diameter altitude hubs for smoother motion. Best of all, IntelliScope Dobs offer fast, easy pointing to more than 14,000 celestial objects with the IntelliScope Computerized Object Locator (sold separately). Buy it now or add it later — the choice is yours!

SkyQuest XT6 IntelliScope $359

SkyQuest XT8 IntelliScope $479

SkyQuest XT10 IntelliScope $649

IntelliScope Computer Controller $149

SkyQuest™ XT Classic Dobs

The classic Orion SkyQuest XT Series is back! The Dobs that *Astronomy* magazine (5/03) called "works of art" sport the same outstanding optical performance and Orion-designed features that earned them their #1 ranking in the marketplace. And now they are priced even lower than before, for amateur astronomers seeking the absolute most bang for the buck. Three sizes to choose from — the choice is yours!

SkyQuest XT6 $299

SkyQuest XT8 $399

SkyQuest XT10 $549

SPECIAL OFFER
FREE
LaserMate™ Collimator
with any SkyQuest Classic Dob (XT6, XT8, or XT10)
Ensures sharp images, best views.

Offer expires 8/10/04

SkyView™ Pro Telescopes

Special Offer!
Order now and receive a FREE TrueTrack™ single-axis drive or save $70 off a TrueTrack™ dual-axis drive.

SkyView Pro 6LT
For anyone interested in extra magnifying power for viewing lunar terrain, Jupiter's bands, Saturn's rings, or double stars, the 6LT will get the job done. The 150mm, 1200mm focal length (f/8) parabolic primary mirror delivers 60% greater magnification than you get from shorter models using the same eyepiece. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces (25mm and 10mm), collimation cap and dust-cap.

SVP 6LT & FREE drive **$479**

SkyView Pro 8
Finally, a telescope that gives views that will blow you away without blowing your budget! A full 8" (203mm, f/4.9) parabolic primary mirror, which gathers 73% more light than a 6". The tube features a 2" aluminum rack-and-pinion focuser and a sturdy 4-vane holder. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces (25mm and 10mm), collimation cap and dust-cap.

SVP 8 & FREE drive **$549**

SkyView Pro 120
Love refractors? We've combined our 120mm achromatic refractor with our super-sturdy SkyView Pro mount. The big fully multi-coated 120mm (f/8.3) objective lens and 2" focuser will give you jaw-dropping views of the skies. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces (25mm and 10mm), 90° star diagonal, collimation tool and dust-cap.

SVP 120 & FREE drive **$549**

SkyView Pro 127
Given the popularity of our 127mm Mak, it's only natural that we offer it with the best mid-sized equatorial mount on the market, the SkyView Pro. The 5" Maksutov-Cassegrain optics pull in plenty of light for great views of deep-sky gems. And you can't beat its long focal length of 1540mm (f/12.1) for high-magnification study of the Moon and planets. Includes 6x30 finder scope, two 1.25" Sirius Plössl eyepieces, (25mm and 10mm), 90° mirror star diagonal, optical tube carry case and dust-cap.

SVP 127 & FREE drive **$649**

StarMax™ EQ Maksutov Telescopes

Purchase a StarMax now and get a FlexiShield dew cap, worth up to $18.95 — FREE!

StarMax scopes pack long focal lengths into a compact, portable tube. They're the ultimate grab-and-go telescopes, providing excellent high-power views of the Moon and planets, plus sharp images of bright deep-sky objects. Comes complete with equatorial mount, quality accessories, and optical tube carrying case.

StarMax 90mm Mak + FREE FlexiShield **$289**
StarMax 102mm Mak + FREE FlexiShield **$389**
StarMax 127mm Mak + FREE FlexiShield **$569**

MONEY-BACK 100% Satisfaction GUARANTEE
If you are not completely satisfied with your purchase from Orion Telescopes & Binoculars for any reason, just return it in new condition within 30 days after delivery for a prompt refund.

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Information Line Hours: M–F 6am–8pm, Sat. 8am–6pm Pacific Time
Prices subject to change

telescope.com

NEW AND NOTABLE

Waist Case™ Accessory Holder
Keeps your most-often used accessories right at your fingertips. Foam interior has seven die-cut holes for 1.25" and 2" eyepieces. Front and side pockets hold filters and other accessories. Belt adjusts to any waist size.

$32.95

SkyLine™ Green Laser Pointer
Point right to the Orion Nebula, or trace the outline of the Sagittarius "Teapot." SkyLine's thin but distinct green beam appears to stretch all the way to the stars! A great teaching aid for night-sky viewers. Two AAA batteries and case included.

$129

Orion Aluminum Focus Wheels
Replace those standard plastic focus knobs with these stylish aluminum wheels, complete with rubber grip. They fit most Orion telescopes and many other scopes (see telescope.com or call for list). Set of two wheels with mounting screws.

$19.95

Dynamo™ Pro 17 DC Power Station
Power your 12V telescope drive and accessories. Portable 17 amp-hour battery features two 12V "cigarette lighter" ports, cabled red flashlight, halogen spotlight, built-in AM/FM radio, and auto jumper cables. Fully rechargeable; includes AC and DC adapters.

$109

V-Block Anti-Fringing Filter
What a difference! Enhances sharpness and contrast of images in achromatic refractors by dramatically reducing color fringing. Threads into eyepieces, barlows, diagonals that accept filters.

1.25" ~~$69.95~~ **$49**
2" ~~$89.95~~ **$69**

EYEPIECES

Ultrascopic™ Eyepieces
Upgrade from Plössls for better images. Fully multi-coated, Japanese-made optics deliver flat-field images of exceptional resolution. Each comes with detachable winged rubber eyeguard. The 1.25"-diameter barrels are threaded for filters.

From $89

HighLight™ Plössl Eyepieces
Our premium line of Plössls provide that extra performance edge. Optics are fully multi-coated for highest possible brightness and contrast. Unique knurled-metal grip. Generous 52° apparent field (40mm, 43°). The 1.25"-diameter barrels are threaded for filters.

From $54.95

Sirius™ Plössl Eyepieces
Enjoy excellent image sharpness and contrast for a great price. Fully coated, 4-element optics offer a 52° apparent field (40mm, 43°). Ideal for all types of telescopes. The 1.25"-diameter barrels are threaded for filters.

From $42.95

Electronic Imaging Eyepieces
View real-time images of the Moon, planets, or terrestrial subjects on a TV, or record on a VCR for later playback or frame-grabbing. Monochrome and color models fit any 1.25" focuser or diagonal. Cable and 9V battery included.

Monochrome **$64.95**
Color **$119**

Epic™ ED-2
Wide 55° apparent field and luxuriously long 20mm eye relief, thanks to two of six elements made from extra-low dispersion "ED" glass, which boasts superior refractive properties. The 1.25"-diameter barrels are threaded for filters.

From $64.95

FILTERS

Full-Aperture Solar Filters
View the Sun safely, in natural color. Enjoy great views of sunspots! Triple-coated glass blocks 99.999% of incoming light. Aluminum cell. Sizes to fit telescopes apertures from 3.5" to 12". See complete list at telescope.com.

From **$54.95**

Moon Filter
Neutral-density filter reduce lunar surface glare to reveal much more detail. Works with any telescope and at any Moon phase. Antireflection coatings prevent ghosting. Anodized aluminum cells.

1.25" 13% Transmission **$14.95**
1.25" 25% Transmission **$14.95**
2" 13% Transmission **$19.95**

SkyGlow™ Broadband Filters
Blocks the most common wavelengths of light pollution, enhancing contrast on all deep-sky objects, especially emission nebulas. Great for viewing in areas of moderate light pollution.

1.25" **$59.95**
2" **$74.95**
SCT **$79.95**

UltraBlock™ Narrowband Filters
A must for observing in areas of heavy light pollution, or for maximum contrast enhancement on emission nebulas. Anodized aluminum cells.

1.25" **$79.95**
2" **$99.95**
SCT **$110**

Stargazer's Filter Set
Save on these four essential filters, complete with foam-lined protective case. Includes SkyGlow, Moon filter, #25 red and #80A medium blue color filters (1.25"). For beginning to advanced stargazers.

$79.95

Deluxe Stargazer's Filter Set
For the observing enthusiast, this six-filter collection is all you need. Includes SkyGlow, variable polarizing filter, and four color planetary filters (1.25") in one carry-all case.

$114.95

OBSERVING AIDS

Orion LaserMate™ Deluxe Collimator
For precise collimation of your reflector's optics. The LaserMate Deluxe turns collimation into a one-step process by adding a "rear view" port so you can see both the emitted and return beams while standing at the rear of the telescope. Both fit any 1.25" eyepiece holder.

LaserMate Deluxe Collimator
$79.95

Orion Helical Fine-Focusing Adapter
This precision-machined adapter makes fine focusing a breeze. It replaces the 2"-to-1.25" eyepiece adapter in scopes equipped with a 2" focuser, allowing very fine helical focusing with just a feather touch. Features dual rubber grip rings and setscrew lock. Works with 1.25" eyepieces. Requires at least 9mm inward focus travel.

$44.95

Shorty™ 2x Barlow Lens
This compact barlow is just 2-7/8" long, about half the length of a regular barlow, for greater convenience and versatility. Fits all 1.25" telescope eyepieces. Features a multi-coated, baffled achromatic lens system.

$39.95

MegaView™ 80mm Binoculars
Premium giant binoculars with high-power optics and cross-reinforced aluminum body and sliding tripod mounting post for optimum balance. Fully multi-coated 80mm lenses with BAK-4 prisms. Long eye relief. made in Japan.

15x80	3.5° field	**$479**
20x80 WA	3.5° field	**$489**
30x80 WA	2.3° field	**$499**

Orion Mini Giant™ Binoculars
Ideal for binocular astronomy, these Mini Giants deliver bright images of celestial objects without the weight or bulk of larger binoculars. BAK-4 prisms are fully multi-coated; aluminum barrels are internally glare-threaded. Eyepiece design yields long eye relief for viewing comfort. Includes hard case, wide neck strap and lens caps.

8x56 Mini Giant	**$159**
9x63 Mini Giant	**$189**
12x63 Mini Giant	**$209**
15x63 Mini Giant	**$219**

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Anyone can sell you a telescope.

Selling you the right telescope means listening carefully to what *you* want to see and do with a telescope – to match your needs and dreams to your budget. It means answering your questions truthfully and fully. It means taking the time to explain your options. It means using our experience – a staff total of over 160 years of experience using and selling telescopes – to make sure that you get the scope and accessories that work together properly and do what you want to do . . . the scope and accessories that are right for *you.*

We've been helping people choose the right telescope since 1979. We have the experience to help *you* pick the scope that fits your needs (and your budget) from the hundreds of telescopes we stock. And, with our seven-figure inventory, we can usually ship you the right scope right away.

We started ***astronomics*** over 25 years ago because we loved astronomy, not just as a business. Our sales may have grown over a thousand-fold since that first year, but we're still the same family-owned, family-run, full-line telescope dealer we were in 1979. And we still love astronomy.

astronomics. No hard sell. No guesswork. Just honest advice, the time to make sure you get the right telescope and accessories, and a good price. Call us toll free at (800) 422-7876 and find out for yourself.

We ship Meade LX200GPS-*SMT* go-to scopes from stock.

Meade 8" LX200 GPS SMT **$2195**

Meade prices are about the same anywhere you call. So why order a 7" to 10" Meade LX200 from a dealer who charges your credit card, then makes you wait and wait until he gets around to ordering? Not when you can usually get the Meade you want . . . right now . . . at the right price . . . right here at ***astronomics.***

Meade LX200GPS scopes have performance and features galore. Optional UHTC optics can increase light transmission by as much as 20% so you can see 20% more of the Universe.

A *fully automatic* GPS system takes the time out of setting up your LX200 and aligning it on the sky. You start observing in minutes.

Smart Mount Technology can improve your scope's pointing accuracy as you observe. A supplied Lunar Planetary Imager takes digital color pictures for you.

The Autostar computer has a built-in database of over 145,000 stars and objects. It will find any of them for you *automatically*. You'll spend more of your time looking *at* heavenly bodies and less time looking *for* them.

Optional Meade Sky Assurance™ extended service programs can extend your telescope warranty to three or five years – *or longer!*

Here are the LX200GPS scopes we ship from our stock:

7" Maksutov-Cassegrain ..... **$2695**[00]
7" Maksutov-Cassegrain, w/UHTC ..... **2845**[00]
8" Schmidt-Cassegrain ..... **2195**[00]
8" Schmidt-Cassegrain, w/UHTC ..... **2370**[00]
10" Schmidt-Cassegrain ..... **2745**[00]
10" Schmidt-Cassegrain, w/UHTC ..... **2980**[00]

Here are the LX200GPS scopes Meade ships from the factory due to their weight:

12" Schmidt-Cassegrain ..... **3595**[00]
12" Schmidt-Cassegrain, w/UHTC ..... **3890**[00]
14" Schmidt-Cassegrain ..... **4995**[00]
14" Schmidt-Cassegrain, w/UHTC ..... **5345**[00]
16" SCT, w/altazimuth pier and UHTC .... **15,645**[00]
16" SCT, w/equatorial pier and UHTC ..... **15,845**[00]

We actually stock TeleVue.

NP-101 **$3595**

To sell seven figures worth of TeleVue a year, you have to keep a lot of TeleVue in stock so you can ship fast and keep your customers happy. We *do* keep a big inventory on hand, so our customers are *very* happy. Others may say they carry TeleVue, *but we actually keep TeleVue in stock.* Lots of it.

Here are a few of the TeleVue refractors that we keep in stock for immediate shipment.

Pronto, 2.7" f/6.8 semi-apo ..... **$1120**[00]
TV-76, 3" f/6.3 apo ..... **1675**[00]
TV-85, 3.35" f/7 apo ..... **2080**[00]
TV-102, 4" f/8.6 apo ..... **2635**[00]
Renaissance 102, 4" f/8.6 brass apo ..... **3175**[00]
NP-101, 4" f/5.4 apo ..... **3595**[00]

All of the above refractors come without a mount, but include an eyepiece (except the NP-101), an enhanced aluminum or Everbrite 99% reflectivity star diagonal, a carrying case, and a tube ring for mounting. Optical tubes only, without these accessories (such as the new **TV-60** apochromatic at $795), are also available from stock.

Does your dealer?

As for accessories, we stock them all. For example, here are a few of the newest eyepieces from TeleVue that we can ship today.

2-4mm 1.25" Nagler zoom ..... **$395**[00]
2.5mm 1.25" Nagler Type 6 ..... **280**[00]
3.5mm 1.25" Nagler Type 6 ..... **280**[00]
11mm 1.25" Nagler Type 6 ..... **280**[00]
20mm 2" Nagler Type 5 ..... **440**[00]
41mm 2" Panoptic ..... **495**[00]

Whether it's a Gibraltar, Panoramic, or Tele-Pod mount; a Sky Tour computer; a Nagler, Radian, Panoptic, or Plössl eyepiece; a Powermate or Barlow; an Everbrite 99% reflectivity star diagonal; a light pollution filter, or a BinoVue – if it's TeleVue, it's in stock.

> I just wanted to thank you for sending me such a wonderful telescope (Tak FS152) and mount (Tak EM-200). As always you guys are honest, sincere and everything arrives as ordered and when ordered. I do and will continue to recommend Astronomics to anyone interested in buying from a quality company.
>
> **Customer Quote of the Month #150**

Everyone can afford CCD when cameras start at $249!

Low cost **SAC Imaging** CCD cameras finally make serious CCD imaging possible at sensible prices. Even the owners of small telescopes such as the Meade ETX-90 can do serious CCD imaging with a very affordable SAC camera.

SAC7B cooled 24-bit color **$499**

Whether it's short exposure lunar and planetary shots, long exposure deep space photos, black and white imaging, single-pass full color, tri-color with a filter wheel, or auto-guiding – there's an inexpensive SAC CCD camera to do it. You'll find full details and pricing on all of them on our website at **www.astronomics.com**.

Eyepiece cases start at only $2[49].

These plastic bolt-style containers keep your eyepieces free from dew and dust. Foam inserts cradle your eyepieces to protect against accidents. At **www.astronomics.com** we list which containers hold which eyepieces.

42mm x 60mm holds most Celestron Omni and E-Lux, Meade Series 3000, and TeleVue Plössls. ..... **$2**[49]
52mm x 80mm holds TeleVue Radians, Nagler Type 6, most Barlows, large Celestron Ultimas, etc. ..... **$3**[49]
65mm x 80mm holds most illuminated reticles, 22mm Panoptic, 12mm Nagler, etc. ..... **$3**[99]
65mm x 120mm holds longer Barlows, 55mm Plössl, 22mm and 27mm Panoptic, etc. ..... **$4**[99]

There are new extended shopping hours at astronomics . . .

For your convenience, we've extended our telephone hours until 9 PM CST Monday through Friday. You can call late and still get the friendly, reliable Astronomics service you've come to rely on for more than 25 years. Our regular telescope experts will be available to answer your questions, not just order takers – so you can call us late for all your telescope needs!

Our *38* light pollution filters make bright skies dark.

Are city lights washing out your view of the skies? Improve your deep space observing by dimming those annoying lights with one of the many light pollution reduction filters we stock.

Some dealers carry only a few filters to reduce the effects of light pollution. We carry 38. We have one that's exactly right for you.

We have two **Celestron** broadband filters. One is designed to fit 1.25" eyepieces; the other to fit Schmidt-Cassegrain (SCT) rear cells.

We have 13 **Lumicon** Deep Sky broadband, UHC narrowband, and H-Beta and Oxygen III line band filters for use in 1.25" and 2" eyepieces, as well as on SCT rear cells.

We have six **Meade** broadband, narrowband, and Oxygen III filters in 1.25" eyepiece and SCT rear cell versions.

We have four **Sirius** contrast enhancement and nebula filters for 1.25" and 2" eyepieces, plus a unique 1.25" *variable* nebula filter.

We have four **TeleVue** Bandmate NebuStar UHC-type narrowband and Oxygen III line band filters in 1.25" and 2" eyepiece versions.

We have eight **Thousand Oaks** broadband, narrowband, Oxygen III, and H-Beta filters in both 1.25" and 2" eyepiece versions.

Why wait for another dealer to *order* your scope?

We'll ship your Meade LX90 from our stock *now.*

$1695

Some dealers don't even stock the telescopes they sell. Why wait for a non-stocking dealer to finally get around to ordering an LX90 for you to enjoy?

The LX90 is almost always in stock at ***astronomics.*** We had over a dozen in inventory as this was written, so you can probably get *your* LX90 from us with little or no delay.

The **Meade LX90** 8" Schmidt-Cassegrain lets you enjoy go-to astronomy for not a lot of money. It costs only $1695. For that price you get a heavy-duty adjustable height tripod; 26mm Super Plössl eyepiece; an Autostar computer hand control with a memory of 30,223 stars, planets, and deep space objects it can find and track for you; a big 8 x 50mm finder; and more. It's a lot of telescope at a very reasonable price.

Only $995 for a 5" GPS-ready Celestron SCT.

$995

The **Celestron NexStar 5i** is the *only* 5" telescope that has an automatic GPS satellite alignment system available as an option. The NexStar 5i has a computer hand control with a 45,000+ star and object database, adjustable height tripod, red dot finder, eyepiece – everything you need to start observing immediately!

Multicoated optics are *standard equipment* with the Celestron NexStar 5i, not an option as with other scopes. NASA uses Celestron 5" multicoated optics on the Space Shuttle. Don't your eyes deserve the same premium image quality?

the Nexstar 5i is shown with optional photography accessories

Celestron starter scopes packed with features and value.

Celestron StarHopper Dobsonians are loaded with useful features. Roller bearings with dozens of support points ride on a broad azimuth track for smooth hitch-free horizontal motion. Altitude bearings ride on nylon rollers for an equally smooth vertical motion. There's a variable tension altitude clutch to compensate for different eyepiece weights. Finderscopes (a 6x30mm on the 6" and a 9x50mm on the 8" through 12") are mounted in easy-to-align quick release brackets. The 8" through 12" scopes use a 2" metal rack and pinion focuser (with 1.25" adapter) and come with a 2" 32mm E-Lux eyepiece (the 6" scope has a 1.25" metal rack and pinion focuser and 25mm Plössl). The 10" and 12" scopes have a built-in battery-operated cooling fan for their primary mirrors. All have fast cool-down metal tubes and BK7 optical glass mirrors.

8" f/6 StarHopper **$349**

Here are the prices for the fully-equipped Celestron StarHopper Dobsonians.

6" f/8 StarHopper ..... **$249**[00] + $49 freight
8" f/6 StarHopper ..... **349**[00] + $59 freight
10" f/5 StarHopper ..... **499**[00] + $69 freight
12" f/5 StarHopper ..... **849**[00] + $99 freight

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Antares 12 x 80mm **$174**[95]

Antares 8 x 50mm and 12 x 80mm right angle finders are affordably priced from $79[95] to $239[95]. You can get yours in a Celestron black, Meade blue, or gloss white finish. Choose from either a standard erect mirror image or an erect right-reading image that shows you the sky the way it appears on star charts. Each is available with dark crosshairs or with a unique built-in cordless red disk illuminator. Economical optional quick release mounting brackets are also available.

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New Meade LXD75 scopes to make astronomy easy.

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Even if you don't know the skies, you won't spend all your time hunting for planets and deep space wonders with one of the new and enhanced **Meade LXD75** go-to reflectors, refractors, or Schmidt-Cassegrains.

A few touches on the scope's Autostar hand control speeds your LXD75 to any of 30,000+ stars and objects in its memory and tracks it accurately for as long as you want to observe. You spend more of your time looking *at* celestial objects and less time looking *for* them with a go-to Meade LXD75.

Each is complete with tubular steel leg adjustable height tripod, dual motor drives, finderscope, eyepiece, illuminated polar finder, Lunar Planetary Imager digital camera, and Autostar computer to take the guesswork out of finding your way around the skies.

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You can get your Meade Sky Assurance™ extended service plan from us – *even if you didn't buy your Meade scope from us!*

Sky Assurance™ service contracts extend Meade's standard telescope warranty from one year to your choice of either three or five years. *The service contract even covers normal wear and tear!*

You can enroll for extended service when you buy your telescope, or as late as one month before the expiration of the normal warranty period. In other words, you have eleven months from the date of purchase to decide whether you want to extend your warranty.

Sky Assurance™ contracts are renewable in three or five year increments for as long as you own your telescope. They are even transferable to a new owner, should you sell your telescope while it is covered by a contract. Here's a sample of the 3-year Sky Assurance™ contract prices for some popular Meade scopes.

ETX-90, 3-year Sky Assurance **$64.99**
LX90, 3-year Sky Assurance **144.99**
8"/10" LX200, 3-year Sky Assurance **244.99**
12"/14" LX200, 3-year Sky Assurance **329.99**
16" LX200, 3-year Sky Assurance **1349.99**

Full Meade Sky Assurance™ plan details are available on our website, along with the 3-year and 5-year extended service contract pricing for all Meade telescopes from under $199.99 to $16,999.99.

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You don't need a telescope to enjoy astronomy. Many of the wonders of deep space – nebulas, galaxies, and star clusters – are all visible through Celestron binoculars, as are myriad craters and mountains on the Moon.

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The **10 x 50mm Optiview LPR**, left, has a secret weapon for astronomy. It has built-in light pollution filters to block the glare of city lights that can wash out faint deep space detail.

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The big **25 x 100mm Skymaster,** below, (which has the light-gathering power of two 4" telescopes, one for each eye), gathers huge amounts of light for serious deep space observing. Like all Celestron Skymaster binoculars, it includes an adapter for use on a photo tripod.

$349

Denkmeier Binoviewers are optimized for *your* scope.

Use both eyes to observe through a **Denkmeier Binoviewer**, and you see up to 40% more detail than you can when looking through a single eyepiece. Your views of the planets, Moon, and deep space objects become almost three-dimensional.

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New lower-priced SBIG ST-7XME CCD cameras!

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SBIG has reduced the price of their ST-7XME self-guiding CCD camera, and added two new versions for as little as $1495!

The ST-7XME Standard is only $1995. It has a Class 2 imaging detector with microlens technology and no column defects, large TC-237H guiding detector, custom case, high speed USB interface, thermoelectric cooling with whisper fan, and more.

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Why wait for another manufacturer to build and ship a scope to you? We ship **Celestron Advanced Series** go-to telescopes from *our* stock daily. These Celestron scopes put multicoated optics on an easy-to-use go-to mount. From a 5" Schmidt-Cassegrain (with optics so good that NASA flies them on the Space Shuttle) to a 10" reflector, there's a Celestron go-to that's right for you and your budget. Scopes available from stock include:

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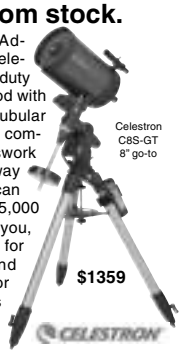

$1359

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We've added more products and features to our award-winning website. There are new calculators – for CCD cameras, eyepieces, Barlows, camera adapters, and more. You can do side-by-side product comparisons. Look at any product and we tell you if you can save money on a used one. And that's just a taste of the many useful new features in store for you.

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The Celestron C130M is an easy (and very cost-effective) way to get into the world of high power Maksutov optics.

Andwe have a **C90M** waterproof 90mm version of the C130M in stock at only $209.95!

Buy one Power Tank instead of hundreds of batteries.

Most telescope motors today run on flashlight batteries. Instead of buying eight new batteries every few weeks to keep your telescope going, buy one **Celestron Power Tank** rechargeable battery instead.

7 and 17 amp-hour capacity Power Tanks have the power you need to run your telescope and accessories all night long, and can be recharged hundreds of times. That saves you hundreds of dollars over the cost of constantly buying batteries every few weeks.

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Hot scopes and accessories from William Optics!

$130

How much would you pay for a 97% reflectivity 1/10th wave accuracy 2" enhanced aluminum mirror diagonal with 1.25" eyepiece adapter? Some competitors charge up to $250 for that combination. But the **William Optics** 2" diagonal shown above (our part #W2) is only $130!

A 2" *99% reflectivity* 1/10th wave accuracy *dielectric* mirror diagonal for Schmidt-Cassegrains, with 1.25" eyepiece adapter, costs a total of $360 from a competitor. But the William Optics dielectric diagonal to the right (our #W2DSCT) is only $230!

$230

The 2" rotatable Schmidt-Cassegrain zero image shift Crayford-style manual focuser with a 1.25" eyepiece adapter to the left (our #WSCTF) is only $149. As with all William Optics scopes and accessories, it offers exceptional value – fine optical performance and quality mechanics, at a price less than similar competitive products.

$149

The **William Optics Megrez 80 II APO** *fluorite triplet* 80mm f/6.25 apochromatic refractor optical tube to the right has outstanding optics – truly excellent color correction, very high contrast, tack sharp images – for *$200 less* than a competitive triplet apo that's similarly equipped.

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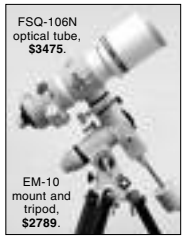
Takahashi premium fluorite apo optics are on sale.

If anything is better than the superb optics of a **Takahashi** *fluorite apochromatic* refractor, it's the speed at which you can get Takahashi optics from our stock. And even better than the fast delivery are the sale prices on Takahashi's best-selling optical tubes.

Regularly $1379, the 3.1" **FS-78** fluorite doublet is sale priced at **$1195!** You save $184!

Takahashi's unique 90mm f/5.6 **Sky 90 II** is sale priced at **$1949!** Regularly $2379, you save $430! *Sky & Telescope* called this compact scope "an ideal travelscope for mobile observers, providing maximum performance at minimum size."

The latest 4" **FS-102 II** fluorite doublet with sliding dew shield is **only $1995**! Regularly $2449, you save $454!



The 5" **FS-128** fluorite doublet is **only $4495**! Regularly $5249, you save $754!

Finally, the big 6" **FS-152** fluorite doublet optical tube is on sale for **only $6995**! Regularly $9329, you save $2334!

We also stock the compact 22" long Takahashi **FSQ-106N** 4" f/5 four-lens *dual fluorite* astrograph apo with 4" focuser, shown to the left on an optional mount.

If you want a premium apo refractor at a money-saving sale price, and you want it without a lo-o-o-ng wait, the refractor you want is a Takahashi from ***astronomics***.

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Listening for a whisper

IN THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI), progress is sometimes hard to measure. Yes, the data rates at today's SETI telescopes would choke a hippo, and sure, new hardware and software are able to comb through a hundred million channels of cosmic static faster than you can say "Jodie Foster." But the bottom line remains the same: still no confirmed signal from any other world.

In light of this failure to find aliens, some pundits urge us to rein in our expectations. They caution that SETI should be viewed as a "project for the generations." Could this be true? After all, SETI has carefully investigated only a tiny volume of the galactic bailiwick. At today's rate of scrutiny, it will take centuries or even millennia to check for faint signals from as much as 1 percent of the Milky Way's star systems.

But today's rate of scrutiny is just that — today's rate. In fact, the technology used to hunt for signals is improving exponentially with time. SETI's on a roll, and the time scale for finding an alien signal could be far shorter than anyone can imagine.

AN INHABITED PLANET elsewhere in our galaxy might appear different than Earth. In this painting, an advanced civilization resides on the earthlike planet in the background. To search the sky for other life, they have constructed a huge radio telescope on the far side of their moon. ILLUSTRATION BY LYNNETTE COOK

Researchers involved in the search for extraterrestrial intelligence are pinning their hopes on new technology.

/// BY SETH SHOSTAK

In addition, the great appeal of the search continues to stoke the imagination of scientists around the world. During the last year, a gush of new ideas about both the technology and the sociology of SETI has burst on the scene.

Listening with new technology

It's been more than four decades since Frank Drake first swung an 85-foot-diameter radio telescope in the direction of Tau Ceti and Epsilon Eridani (two Sun-like stars within a dozen light-years of Earth) hoping to find signals broadcast by alien neighbors. Drake tuned his receiver to the microwave band at 1420 MHz, equivalent to a wavelength of 21 centimeters. The majority of today's SETI practitioners do the same. 21cm is special because cold, interstellar hydrogen gas radiates at this wavelength. Once radio astronomers realized this, they were able to map most of the Milky Way Galaxy by plotting the positions of vast hydrogen clouds.

The perennial difficulty with speeding up SETI has been the lack of a large, dedicated radio telescope optimized for a systematic hunt. That hole is about to be plugged. The SETI Institute and the Radio Astronomy Lab at the University of California, Berkeley are building a new instrument that will accelerate enormously the examination of individual star systems. Christened the Allen Telescope Array (ATA) in appreciation of generous funding provided by Paul G. Allen (cofounder of Microsoft), this instrument departs from the usual radio-telescope design. Instead of a massive, single reflector (*à la* Arecibo in Puerto Rico), or a small array of relatively large telescopes (*à la* the Very Large Array in New Mexico), the Allen Telescope Array will sport hundreds of dishes, each with reflectors 20 feet in diameter.

The ATA is being constructed at Berkeley's Hat Creek Radio Observatory, located on ranch land in the Cascade Mountains about 250 miles northeast of San Francisco. According to Leo Blitz, the Radio Astronomy Lab's director, "this is probably the best spot in the country to put the array. The population density is low, and consequently, so is the level of radio interference." Three of the ATA antennae already have been planted, outfitted, and checked. By the end of the year, a "mini-array" of 32 dishes will be in place. Eventually, 350 antennae will spread irregularly throughout a circle about two-thirds of a mile in diameter.

THE VERY LARGE ARRAY (VLA) is a collection of 27 radio antennae located at the National Radio Astronomy Observatory site in Socorro, New Mexico. Each antenna in the array measures 82 feet (25 meters) in diameter and weighs about 230 tons. The Y-shaped array can be arranged into 4 different configurations, depending on the distance between each of the antennae. NRAO/AUI

A new breed

So what will the ATA do that existing telescopes cannot? To begin with, the array will cover a very wide sweep of the radio band, from 500 to 11,200 MHz — all at the same time. Second, those small, individual dishes provide a broad field of view, 2.5° at 21cm wavelength (the VLA's field of view is 0.6°).

THE ROBERT C. BYRD GREEN BANK TELESCOPE (GBT) is the world's largest fully steerable radio telescope. It is located in Green Bank, West Virginia. The GBT stands 485 feet (148 meters) tall. Its dish measures 330 by 360 feet (100 by 110 meters). NRAO/AUI

Third, an array with hundreds of antennae produces radio pictures with exceptional dynamic range; strong radio sources will reveal their faintest features.

Some of the research areas where the ATA will excel include mapping the neutral hydrogen in galaxies out to a distance of almost 900 million light-years, detecting gravity waves, and finding very slow pulsars. Mapping galaxies and sniffing out pulsars are pretty straightforward, but you might wonder how a radio telescope could ever be used to detect gravity waves. Keep in mind that gravity warps space. Then imagine that deep in the chaotic innards of a distant galaxy, two massive black holes are approaching one another slowly, the consequence of galactic cannibalism. Such processes flood the universe with enormous gravitational swells, and the resulting space warp slightly changes the times that pulsar signals arrive. With its ability to

measure these changes to a precision better than a millionth of a second, the ATA can gauge the subtle ebb and flow of gravity waves caused by cataclysmic events in the far-off cosmos.

Without doubt, the ATA will help SETI do a better job. But the ATA is not the only system where such reconnaissance will be accelerated. Australian engineers are building a multiple-receiver feed to affix to the Arecibo telescope. This new compound radio eyeball, nicknamed ALFA (Arecibo L-Band Feed Array), is designed to gaze at seven closely spaced spots on the sky simultaneously. According to Dan Werthimer, director of the Berkeley SETI Program, "Once this new hardware is on the telescope, we'll be using it to do a systematic survey. To take advantage of ALFA, we're building a new receiver: the SERENDIP V spectrometer. Actually, it's seven spectrometers, one per feed. Each will individually cover three times more than our current equipment."

The Berkeley team also is planning to upgrade the popular (and free) SETI@home screen saver, used by millions of computer users to hunt for signals. Werthimer's plan is to increase greatly the total bandwidth of the data available for SETI@home, and he's thinking about doing the same for a Down-Under experiment — Southern SERENDIP — so home computers can pore through the cosmic bits and bytes collected by Australia's Parkes radio telescope.

Seth Shostak *is senior astronomer for the SETI Institute in Mountain View, California.*

THE ARECIBO RADIO TELESCOPE, located in Puerto Rico, is the world's largest. Unlike many smaller radio telescopes, the Arecibo installation cannot be pointed to a particular spot in the sky. The telescope is stationary and the sky rotates above it. NRAO

Optical SETI

Radio SETI is on the brink of a major spurt in speed. As it turns out, so is the other popular SETI technique: looking for very brief pulses of light aimed our way by extraterrestrials deliberately trying to get our attention.

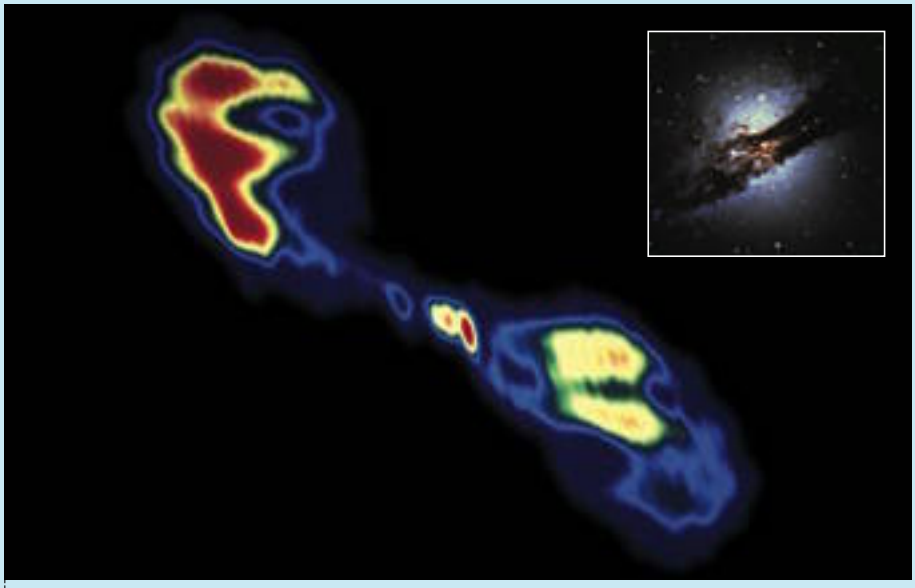
The idea of using visible light as a signaling device is an old one. Even 19th-century scientists considered building mirrors and lanterns to establish connections with clever creatures supposedly residing on the Moon or Mars. More recently, the development of high-powered lasers, able to produce blindingly intense pulses of light for a billionth of a second, has revived this idea. If such a laser were to be coupled to a telescope mirror, it would be capable of pouring into someone else's solar system more photons than our Sun does — at least during the nanosecond flash.

Clearly, if we have technology sufficient for interstellar light communication, then so should advanced aliens. All that may be

required to detect the extraterrestrials in this way is to connect high-speed photomultipliers to our telescopes and scan for far-off flashes.

One of the difficulties with such a search is that the photomultipliers frequently "light up" with pulses that could be extraterrestrial in origin but most likely are just cosmic rays, radioactive decays, and other instrumental effects. The optical SETI experiment at Lick Observatory, which is a collaborative effort with the SETI Institute and Berkeley's Space Sciences Lab, uses three photomultipliers in parallel to reduce the number of false alarms drastically. At Harvard University, Paul Horowitz and his team have concocted a different scheme for eliminating false alarms. They've inspired an enthusiastic team of faculty and volunteers at Princeton University to renovate a mothballed 36-inch telescope to help sort out which signals are real. If a burst of photons from an alien broadcaster lands in the Harvard telescope, then the instrument at Princeton, which is about 300 miles away, should light up roughly a millisecond earlier or later, depending on the transmitter's sky position. That slight difference in arrival time is measured easily, and it is a gold-plated guarantee that the signal really comes from deep space.

While optical SETI has, until now, restricted its gaze to individual star systems, wholesale stellar scrutiny is coming soon. Horowitz's team is building a telescope whose sole purpose is to scan the entire universe visible from Massachusetts. This sky-survey instrument will have a 72-inch mirror and a detector able to image a patch of celestial real estate somewhat larger than the Full Moon. Once up and running (the projected first light is late 2005), the new telescope will sweep the entire sky in about a year's time, dwelling for roughly a minute on any particular patch.



CENTAURUS A (NGC 5128) is a strong source of radio emissions and also a strange galaxy. Two huge regions lying away from the center of the object are the most powerful radio sources known. NRAO/AUI; *INSET:* NOAO/AURA/NSF

When will we know?

Even aside from the new ideas that continually enrich SETI, one thing's for sure: the pace of exploration is accelerating. Any quantitative measure of search speed (for example, the number of simultaneous channels SETI radio receivers can monitor) shows an exponential increase since Drake's 1960 experiment. Indeed, search speed has been following a growth curve known in the computer industry as Moore's Law. This rule of thumb, first enunciated by Silicon Valley pioneer Gordon Moore, states that computing power per dollar doubles every 18 months.

THE ALLEN TELESCOPE ARRAY (ATA) will be a general-purpose radio telescope that will provide new measurements and insights into the density of the very early universe, the formation of stars, magnetic fields in the interstellar medium, and a host of other applications of deep interest to astronomers. At the same time, this 21st-century radio telescope also will have the capability to search for possible signals from technologically advanced civilizations elsewhere in the galaxy. These images show the first three of the 350 dishes to be included in the ATA. SETI INSTITUTE

To learn more about the search for life elsewhere, visit www.astronomy.com/toc

There's no mystery in the fact that radio SETI, at least, follows this law closely: After all, much of SETI's improvement is linked directly to computational power.

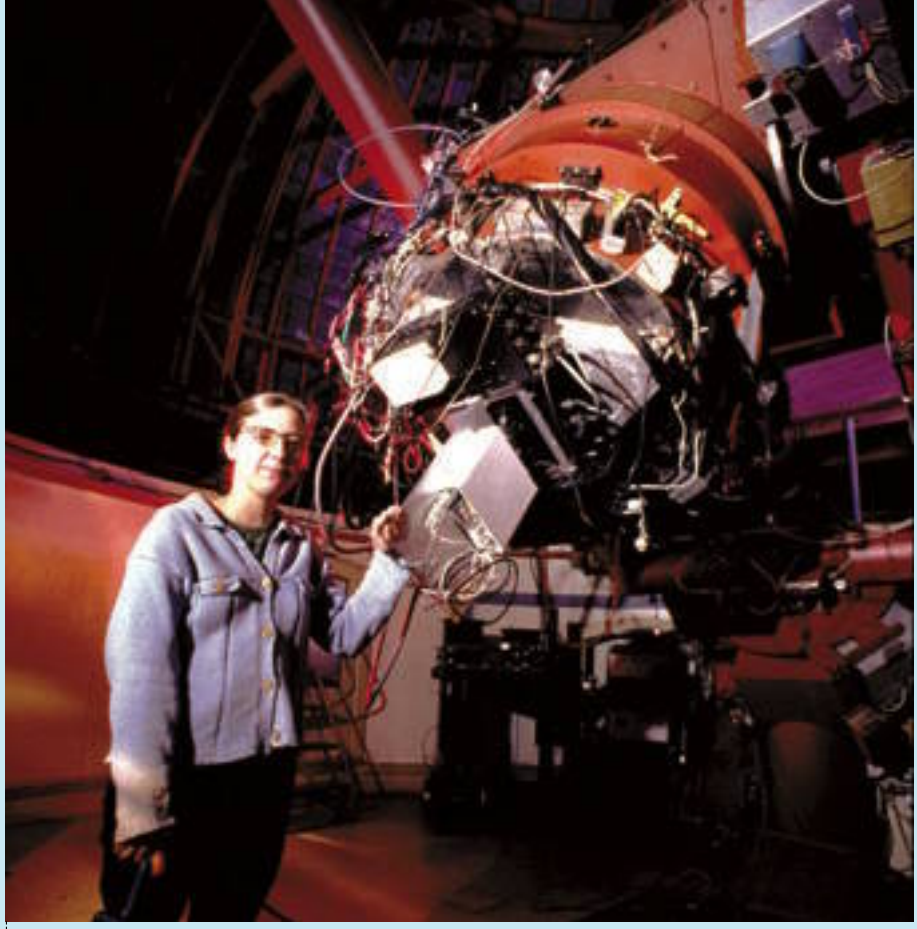
In other words, the speed of scrutiny, at least for facilities like the ATA, is somewhat predictable. So if we knew how many galactic civilizations were broadcasting detectable signals, we could add this to the known rate of improvement in search technology to make an estimate of when SETI will find what it's looking for. How many star systems in our galaxy host intelligent beings with transmitters switched on? The number reckoned by the experts ranges widely: Carl Sagan thought there might be a million or more broadcasting civilizations in the Milky Way. Isaac Asimov figured a half-million. Frank Drake is more conservative: ten thousand.

But even if the lowest of these numbers is correct, and only one in a few tens of millions of stars hosts a technological society, instruments such as the ATA may find something relatively soon. In part, this would be a consequence of improved astronomy. Recent results by researchers hunting for extrasolar planets suggest that stars with higher heavy-element content are more likely to sport orbiting worlds. This type of information will allow us to refine our selection of SETI targets, as will new programs sponsored by NASA's Astrobiology Institute to investigate the habitability of planets around dwarf stars — the most common stellar systems.

Even better target selection will be possible if future space-based telescopes such as the Terrestrial Planet Finder and Darwin find planets whose atmospheres contain oxygen and methane — telltale markers of biology. Of course, just finding worlds with life doesn't imply intelligence (during 99.9 percent of life's history on Earth, none of it was smart enough to build radio transmitters). But if, two decades hence, we have a long list of planets bursting with biology, that would be a tremendously helpful resource for our search for intelligent life.

Even assuming only modest improvements in our ability to narrow our search, I reckon we will have examined enough stellar habitats by the year 2025 to discover an alien transmitter. To arrive at this date, I am taking Frank Drake's relatively conservative estimate of the galactic population of sentient beings.

Of course, some researchers think that even Drake's estimate is far too high; therefore, my prediction of a detected signal in the next two dozen years is optimistic. Only events will prove whether I'm right or wrong, but the bottom line is both simple and encouraging. The search for extraterrestrial intelligence is surfing a thunderous wave: The SETI experiments and the hardware are getting better at an ever-increasing rate. Finding a signal that indicates life elsewhere may be something not for the next generation, but for ours. A



THE OPTICAL SETI PROGRAM is conducted, in part, at Lick Observatory in Santa Cruz, California. Here, Shelley Wright from the University of California poses next to the detector attached to the 1-meter Nickel Telescope used to conduct the search. SETI INSTITUTE

Our local STAR FAC

A burst of star-making erupted in our part of the Milky Way not long ago. You can spot the aftermath of this activity in a sky-girdling ring of bright, naked-eye stars called Gould's Belt. /// BY MATTHEW TERRY

CTORY

Do we really live in a galactic backwater?

Descriptions of our place in the galaxy usually say the Sun sits in an out-of-the-way nook in the Milky Way. It's halfway through its life span, so the story goes, an average star (except for us, evidently), with nothing much to worry about for another 5 billion years. This picture is not inaccurate — indeed, the high drama of "extreme astronomy" luckily occurs far enough away to keep us safe.

But it wasn't always thus. About 30 million years ago, long after dinosaurs went extinct and well into the age of mammals, our region of the Milky Way erupted in a burst of star formation. The skies of

THE BRIGHT OBJECTS in Gould's Belt lie slightly askew relative to the Milky Way. This all-sky view has the Belt as its "equator." How many Belt stars are visible from your observing site? AXEL MELLINGER

AS NEWBORN STARS APPEAR, their stellar winds and radiation clear out the regions where they were born. This Spitzer Space Telescope infrared image shows RCW 49, a star-forming cloud in Centaurus. While the cloud that created Gould's Belt was larger and denser, it worked in the same way. NASA/JPL/CALTECH

Earth back then gleamed with bright, heavyweight stars and, every few thousand years, a brilliant supernova or two blazed forth.

The light show turned on in the northern skies in the direction of the constellation Perseus, although the exact site where the starburst began was obliterated by the tremendous forces it unleashed. Evidence still lingers, however, in the stellar associations and supernovae it spawned. These include many of the stars and nebulae backyard skywatchers know best.

In the Sun's neighborhood, the residue of this episode of galactic fireworks is called Gould's Belt. The Belt circles the sky like the Milky Way (although it's not as prominent), and on any clear night, you can step outdoors and see part of it.

> *forming a stream which . . . comprises the constellation Lupus and a great part of Scorpio, and extends onward through Ophiuchus toward Lyra. Thus a great circle or zone of bright stars seems to gird the sky, intersecting with the Milky Way at the Southern Cross, and manifest at all seasons, although far more conspicuous on the Orion side than the other. . . . This zone of bright stars may be traced with tolerable distinctness through the entire circuit of the heavens, forming a great circle as well defined on the heavens as that of the galaxy itself.*

Since Gould first mentioned the Belt, astronomers have figured out that his "stream" of suns is a remnant ring of stars, disintegrating molecular clouds, and star-forming regions that make a plane roughly 2,000 light-years across. The ring tilts 15° to 20° to the galactic plane; it is expanding in a roughly circular wave from a point about 600 light-years from us. The ring dips below the Milky Way toward Orion and rises above it toward Ophiuchus.

Gould's "stream" of suns is a remnant ring of stars, disintegrating molecular clouds, and star-forming regions roughly 2,000 light-years across.

Naked-eye astrophysics

Spotting Gould's Belt isn't difficult. Here's how its namesake, American astronomer Benjamin Gould, described it in 1874:

> *In the elevated position and clear atmosphere of Cordoba* [Argentina] *. . . few celestial phenomena are more palpable there than the existence of a stream or belt of bright stars, including Canopus, Sirius and Aldebaran, together with the most brilliant ones in Carina, Puppis, Columba, Canis Major, Orion, etc, and skirting the Milky Way on its preceding side. When the opposite half of the Galaxy came into view, it was almost equally manifest that the same is true there also, the bright stars likewise fringing it on the preceding side, and*

This ring includes some of the most famous objects in the sky, such as the Pleiades, the Great Orion Nebula, the Horsehead, the California Nebula, the Coal Sack, and the stunning Rho (ρ) Ophiuchi region near Antares. Most of the stars in the constellations of Orion, Canis Major, Puppis, Vela, Centaurus, and

Matthew Terry *has been using and building telescopes since he saw the Moon rise in eclipse and Comet Hyakutake. He ponders the universe from near his home in Tampa, Florida.*

Scorpius formed at the leading edge of this wave. (There are some notable exceptions. Stars that are bright because they lie close to us include Sirius, Vega, and Alpha Centauri. And a few conspicuous, non-Belt stars are hyperluminous supergiants, appearing bright even across thousands of light-years: Deneb, Tau [τ] Canis Majoris, and Zeta[1] [ζ[1]] Scorpii.)

Most of the blue-white Belt stars visible to the naked eye, however, are very luminous giant and supergiant stars, many of them hundreds of light-years away and visible only because of their tremendous power. Nearly all these stars are offspring of the initial episode of massive star formation and destruction.

Cradles of creation

That kickoff outburst has been traced back to the Alpha Persei moving cluster, also known as the Perseus OB3 association. (Astronomers term such groups OB associations because they contain multitudes of type O and B stars.) According to theory, a massive cloud of cold interstellar gas and dust in this area was intensely compressed. The outcome was a giant molecular cloud that made some very luminous, massive stars. These were bright, emitted strong ultraviolet radiation, and were doomed to short lives.

About 30 million years ago, the heaviest of these stars began exploding in supernovae. Pressure waves from the detonations have been compressing gas into stars within the cloud ever since. Tracing the ages of Gould's Belt stars confirms this. As you go east on the sky through Orion, away from the source of the expansion, Orion's stars get younger. Studies of OB associations in the opposite direction show the same pattern.

The portion of Gould's Belt nearest us is the giant Scorpius–Centaurus OB association. These stars lie an average of about 450 light-years away, three times closer than Orion's stars, and they have let astronomers watch star formation in detail. The shock wave that triggered star-making first reached the region of northern Centaurus and Lupus about 15 million years ago. It then kicked off more stars in the direction of southern Centaurus and Crux about 3 million years later. The process began in northern Scorpius just 5 million years ago.

One of the most photogenic areas of the sky lies here: the Rho Ophiuchi region. Infrared observations show new stars being born within the cloud of dust and gas near the star. Yet unlike the massive clouds in Orion that give birth to brilliant, heavyweight stars, this region's low-density clouds collapse to form Sun-size stars. It has provided a nearby window on the astrophysics of making stars and planetary systems similar in mass to our own.

Rough neighborhood

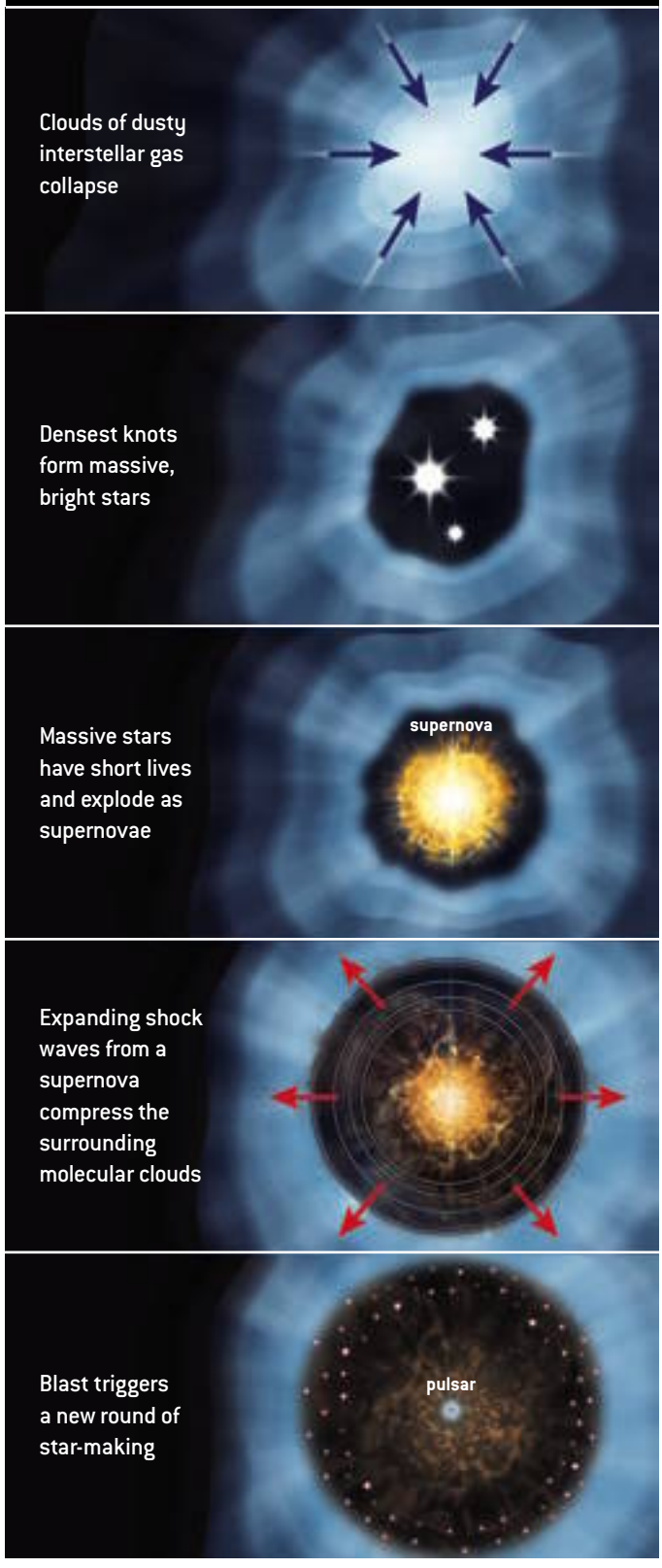
Ironically, while astrophysicists are eager to study quiet regions that make low-mass stars, new results from a team of researchers led by Jeff Hester of Arizona State University suggest the Sun itself was born 4.5 billion years ago in a pretty rough neighborhood, full of massive stars and blasted by frequent supernovae.

"We now know that if you could go back and watch the Sun and solar system forming, you'd see the kind of environment that you see today in the Eagle or Trifid nebulae," says Hester.

What tipped off the astronomers was the presence in primitive meteorites of decay products from short-lived radioactive elements such as iron-60 (half-life: 1.5 million years) that could have come only from a close supernova. These microscopic bits of debris

/// HOW GOULD'S BELT FORMED

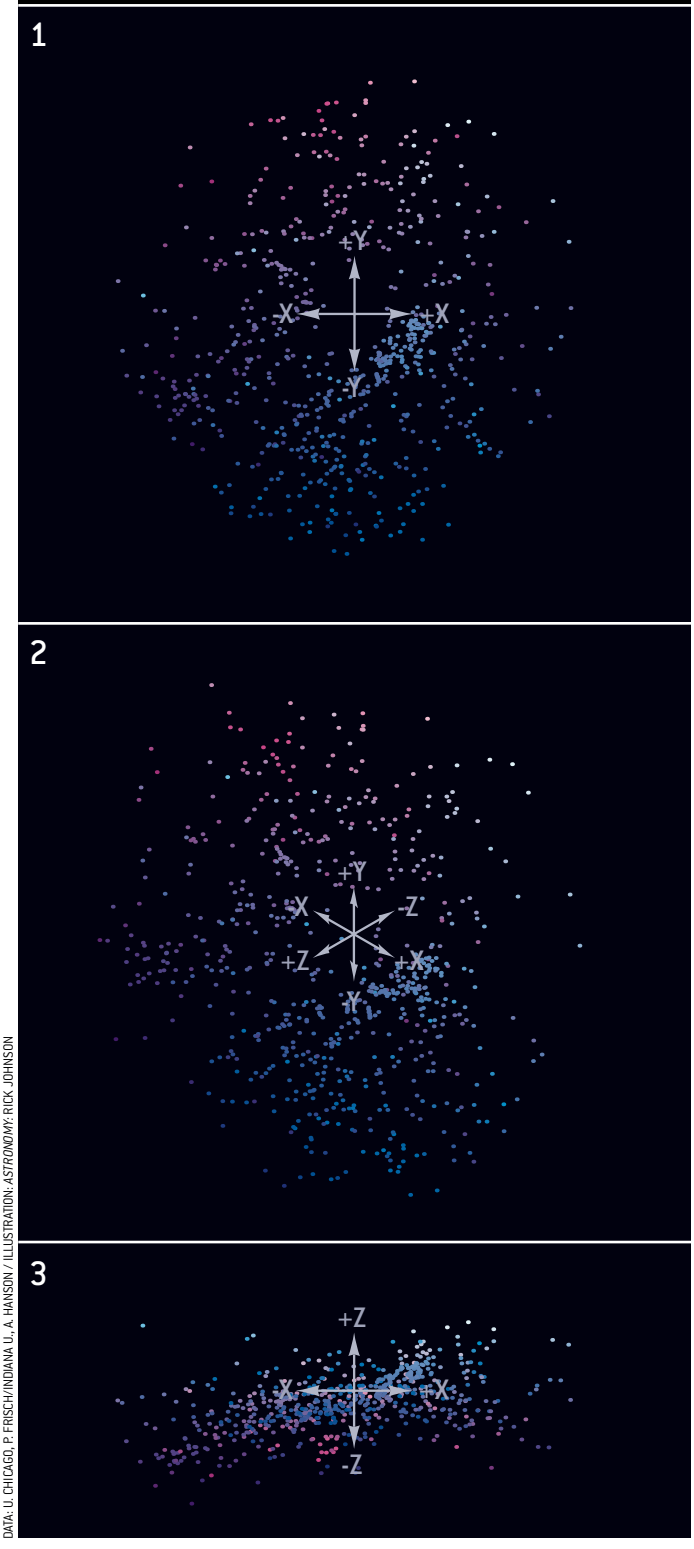
30 MILLION YEARS AGO, a burst of star-making began in the Sun's galactic neighborhood. A giant cloud of gas and dust started to collapse, triggered by the passage of a galactic density wave or perhaps nearby supernovae. Out of the cloud and star-making came the hot, bright stars that make up Gould's Belt.


Clouds of dusty interstellar gas collapse
Densest knots form massive, bright stars
Massive stars have short lives and explode as supernovae
supernova
Expanding shock waves from a supernova compress the surrounding molecular clouds
Blast triggers a new round of star-making
pulsar

ASTRONOMY: ROEN KELLY

/// THREE VIEWS OF GOULD'S BELT

THE SUN LIES AT THE CENTER of these views, and the region shown spans 1,000 parsecs (about 3,300 light-years). [1] Looking down on the plane of the Milky Way, Gould's Belt shows as a "hole." [2] Looking down at a 60° angle conceals the Belt. [3] Viewing the Milky Way edge-on shows Gould's Belt stars tilting about 20° to the galactic plane. (Stars are color-coded from blue to red on the Y axis to help indicate their positions in the plane of the Milky Way.)



DATA: U. CHICAGO, P. FRISCH/INDIANA U., A. HANSON / ILLUSTRATION: *ASTRONOMY*: RICK JOHNSON

were scattered through the material that became the Sun and planets like the seasoning in flour that becomes a loaf of bread. The only way to place it there was by a powerful explosion that strewed the elements throughout a region of space including the protosolar material. Because big explosions come from big stars, and because big stars form in groups within massive clouds, the logic was inescapable: The Sun and planets were born and grew up inside the stellar equivalent of a busy foundry.

How could a proto-Sun survive such a rough-and-tumble environment? The work of the team shows that large molecular clouds always include denser areas. These are at least partly screened from the full violence that follows when massive stars race through their brief lives and explode in the vicinity. Yet the sheltering is only partial. The Arizona State researchers suggest that the abrupt edge of the Sun's Kuiper Belt of icy planetesimals, which lies only around 50 astronomical units out, could be a relic of a birth-process cut short. Perhaps the newborn solar system lost outer material that might have remained if the Sun had formed in a quieter environment.

Pushing and shoving

In any case, as astrophysicists look toward other star-making regions in the Belt, they observe that when individual molecular clouds collapse and become star clusters and associations, the stellar winds drive the interstellar medium in all directions. In this way, even as the fires of Gould's Belt recede from our immediate neighborhood, they still can affect the solar system. The bubble of gas around the giant Scorpius-Centaurus association is expanding under pressure from its stars and pushing thin gas clouds, dubbed the Local Fluff, toward the solar system. The Sun's outermost electromagnetic domain, the heliosphere, is already touching the thin outer portions of this cloud, but the densest parts are estimated to reach us some 50,000 years from now.

What its effects will be are debatable. Astrophysicists suspect that direct encounters such as this may perturb the Oort Cloud, raining comets down upon the inner solar system. But no one knows for sure how such an interaction would affect the heliosphere, which serves to deflect a large percentage of interstellar dust and potentially harmful cosmic rays away from the inner solar system. It would likely compress the heliosphere, moving it inward and closer to the Sun (and Earth), however.

The interactions of cosmic rays with our atmosphere may affect weather — some researchers believe an increased flux of cosmic rays might contribute to starting or stopping an Ice Age, for instance. If they do, climatic changes may be connected with nearby, high-energy gamma-ray sources newly identified in Gould's Belt. Similarly, astronomer Priscilla Frisch of the University of Chicago notes that the Sun has been traveling through the relatively empty middle of the Belt for the last several million years. She wonders if the emergence of *Homo sapiens* in the same time frame is more than coincidental. Many of these notions are intriguing, but much remains speculative.

Seeing a forest in the trees

It took astronomers a long time to understand the importance of what Gould spotted by eye in the 1870s. Most were convinced the Belt was just a curiosity and doubted it was anything other than a chance alignment.

ZOOMING IN ON STARS-IN-THE-MAKING reveals protostars emerging from cocoons of dusty gas, such as these, deep in the Trifid Nebula. The "horns" show where two protostellar systems shield the cloud directly behind them from the strong radiation of hot, massive stars already born. NASA/STScI

The first indications that Gould's stream of stars was indeed related came when photography highlighted the Belt's stars through their color. Being hot, most Belt stars are much brighter in the blue and near-ultraviolet than in the yellow-green part of the spectrum. Because photographic plates in the late 19th and early 20th centuries were strongly blue-sensitive, Belt stars recorded even brighter than the eye saw them, underscoring their link.

In 1922, Edwin Hubble noted that both diffuse bright nebulae and the largest and most opaque dark nebulae congregate along two belts: the Milky Way, and the belt of bright helium stars "which defines the local cluster," the term then used to describe Gould's Belt. That same year, Harlow Shapley showed that stars of spectral types B and A brighter than magnitude 5.25 align with the plane of the Belt, and that those fainter than magnitude 7 follow the galactic disk. Clearly, two stellar groups were at hand.

In the 1950s, Per Lindblad, Adriaan Blaauw, and other radio astronomers found large clouds of neutral hydrogen being compressed along the inside edges of the Belt. That emission and absorption nebulae occupy two distinct zones is obvious from a careful look at most Milky Way panoramas. At large distances from the Sun, nebulae stay in the plane of the galactic disk. But as surveys in the 1960s found, the nearest bright and dark nebulae arc in a slow twist following Gould's Belt. This confirms Hubble's observations from four decades earlier.

In recent years, studies of the galactic magnetic field show its field direction deviates locally to conform with the contours of the Belt. Infrared investigations are now detailing the stellar nurseries within its confines, for example using the new Spitzer Space Telescope, (see page 42).

The power of seeing

The newest discovery regarding Gould's Belt is perhaps one of the most surprising. Using the EGRET gamma-ray detector on the Compton Gamma-Ray Observatory satellite, a NASA team headed by Neil Gehrels discovered a new category of more than 80 "weak" gamma-ray sources aligned within the Belt. These, too, are distinguished from a broader population of more luminous but more distant gamma-ray emitters confined to the galactic plane. Known sources of gamma rays include supernova remnants, pulsars, black holes, and cosmic rays interacting with molecular clouds.

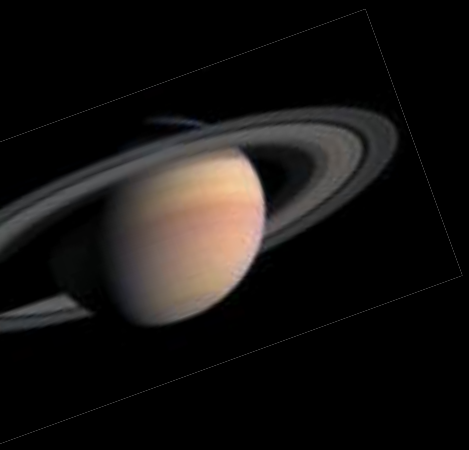
New results suggest the Sun was born in a pretty rough neighborhood, full of massive stars and blasted by frequent supernovae.

It seems clear that, in galactic terms, the solar system lies literally in the thick of things. It's just our own short lifetimes that make it seem so quiet around here.

Isabelle Grenier, a University of Paris investigator of gamma-ray sources in the solar neighborhood, says, "As possible relics of supernova explosions in the Gould Belt, the gamma-ray sources highlight how dynamic the cycle of matter through star formation and death is in our neighborhood — a lively drama that eludes us because of the stillness of the optical sky to our naked eyes." A

For more about Benjamin Gould and his role in developing 19th-century American astronomy, see www.astronomy.com/toc

Cassini spies Phoebe



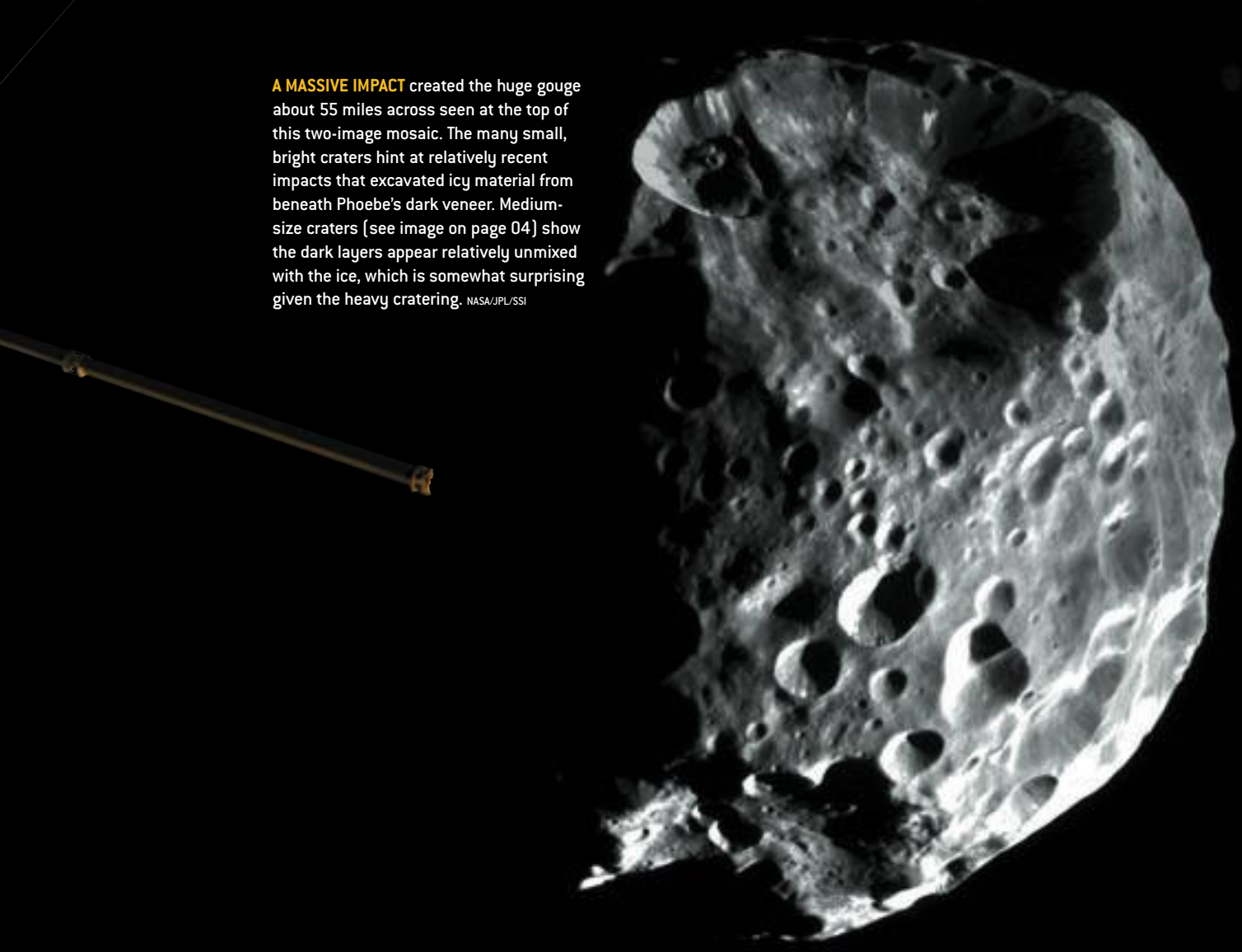
The Cassini spacecraft makes its first close pass by a moon of Saturn, revealing a battered, ice-rich world. /// BY RICHARD TALCOTT

"One down, fifty-two to go." With those words, chief navigator Jeremy Jones of NASA's Jet Propulsion Laboratory (JPL) proclaimed Cassini's flyby of Saturn's outer moon Phoebe a success. On June 11 — three weeks before it entered orbit around Saturn — the Cassini spacecraft skimmed within 1,285 miles (2,068 kilometers) of the mysterious moon's battered surface. A suite of 11 instruments scrutinized a world of ice and rock heavily scarred by impacts throughout the history of the solar system.

SATURN (ABOVE): NASA/JPL/SSI

VOYAGER 2 SAW only a few, very indistinct light and dark regions covering Phoebe. NASA/JPL

AS CASSINI CLOSED IN on Phoebe, it returned ever-sharper images. This sequence shows the moon at distances ranging from 2.6 million miles (far left) to 48,130 miles (far right). The battered surface exhibits overlapping craters with diameters from thousands of feet to 30 miles. NASA/JPL/SSI; CASSINI ARTWORK (TOP): NASA/JPL

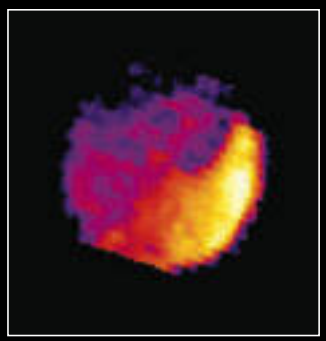


A MASSIVE IMPACT created the huge gouge about 55 miles across seen at the top of this two-image mosaic. The many small, bright craters hint at relatively recent impacts that excavated icy material from beneath Phoebe's dark veneer. Medium-size craters (see image on page 04) show the dark layers appear relatively unmixed with the ice, which is somewhat surprising given the heavy cratering. NASA/JPL/SSI

Before the flyby, planetary scientists knew little about Phoebe. The dark moon measures 135 miles (220 km) across and rotates every 9 hours and 16 minutes. It also orbits Saturn at a larger distance and on a more inclined path than any other of the planet's major moons — and in the opposite direction as well. This suggests that Saturn captured the moon at some point in the distant past. But from where, exactly? Based on the Cassini flyby results,

A SEVEN-IMAGE MOSAIC shows Phoebe at near-maximum detail. (Resolution increases to the right, where smaller craters and blocks can be discerned.) Notice the grooves and chains of pits on the left side of the mosaic. These may mark faults or fractures induced by large impacts. NASA/JPL/SSI

PHOEBE'S SURFACE displays a variety of materials. Exposures of water ice appear as blue, carbonaceous material is in red, and a second carbonaceous "mystery material" (not yet identified) appears in green. NASA/JPL/UNIV. ARIZONA



COLD DOMINATES the surface of Phoebe, which has a peak temperature of 107 kelvins (–267° Fahrenheit), shown in white. The coldest temperature detected (purple) was found on the nightside: 75 kelvins, or –324° F. NASA/JPL/GSFC

Phoebe is a child of the outer solar system. Cassini's instruments detected carbon dioxide ice on Phoebe's surface, indicating a long-frigid history typical of the Kuiper Belt, a disk of ice-rock objects orbiting beyond Neptune. Also, Phoebe's density (1.6 grams per cubic centimeter) resembles that of Pluto and Triton, both Kuiper Belt in origin.

The spectacular images show a rugged topography (total relief: 10 miles, or 16 km) with a wide range of geological structures. "Phoebe is a world of dramatic landforms, with craters everywhere, landslides, and linear structures such as grooves, ridges, and chains of pits," says Alfred McEwen, imaging team member from the University of Arizona. The spacecraft's cameras captured details as small as 50 feet (15 meters) across in the closest views, about 1,000 times better than Voyager 2 accomplished when it flew past in September 1981. Voyager was the last spacecraft to image Phoebe.

The ubiquitous craters range from tiny craterlets as small as the camera could see to behemoths dozens of miles across. The plentiful craters smaller than 0.6 mile (1 km) in diameter suggest that many projectiles less than 330 feet (100 meters) across once pummeled Phoebe. The large craters hint at a different story. Although big impacts tend to be destructive, they can work in creative ways also. For example, some planetary scientists suggest that pieces of Phoebe broken off during these massive collisions gave birth to the other, much smaller moons that orbit on the frontier of the saturnian system in the same direction as Phoebe.

The Cassini images show that Phoebe's dark, carbonaceous veneer likely hides plenty of ice-rich material. Bright, wispy streaks cover the ramparts of the largest craters. These streaks appear to be ice exposed by landslides on the steep slopes of the craters. The many small, bright craters on Phoebe's surface appear to be relatively young features created when incoming meteoroids smashed into the moon's surface. The impacts excavated fresh, bright material — probably water ice — from under the dark surface. Members of the imaging team think the bright streaks and craters strongly suggest that Phoebe has a thin, dark skin some 900 to 1,600 feet (300 to 500 meters) thick wrapped around an icy subsurface.

Richard Talcott *is a senior editor of* Astronomy.

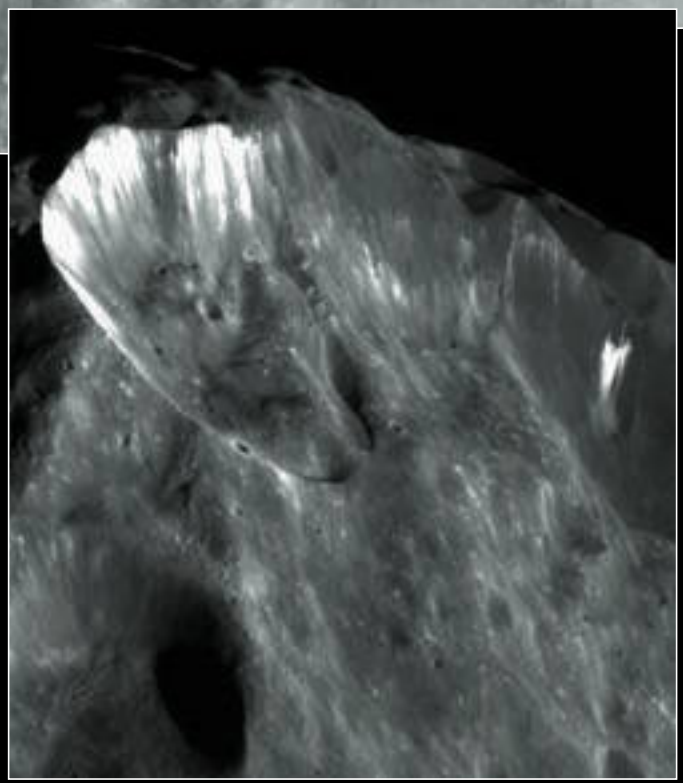
To see a photo gallery of the latest Cassini images, visit www.astronomy.com/toc

"Battered and beat up as it is, Phoebe is still giving us clues to its origin and history," says imaging team member Torrence Johnson of JPL. Says Roger Clark, science team member from the U.S. Geological Survey, "All the evidence leads us to conclude Phoebe's surface is made of water ice, water-bearing minerals, carbon dioxide, and perhaps clays and primitive organic chemicals in patches." In short, Phoebe resembles the primitive icy planetesimals that were the building blocks of the planets.

Planetary scientists will now use the data to create global maps of Phoebe. They will gauge the moon's ice and rock composition, which depends in part on porosity, or how loosely its bulk is packed. Estimates range from about 55 percent rock (assuming no voids) to 75 percent rock (with 30 percent porosity).

One thing mission scientists won't get: another opportunity to visit this unusual moon. Phoebe simply orbits too far from Saturn for the spacecraft to make it all the way out there again.

After the Phoebe flyby, Cassini made one last trajectory correction to put it on target to fly between Saturn's F and G rings. If all went well, Cassini fired its main engine for 96 minutes on June 30 (July 1 in the Eastern Hemisphere) to brake into orbit around Saturn. During its planned four-year tour, Cassini will complete 76 orbits and execute 52 close encounters with 7 of Saturn's 31 known moons. We'll report on the orbit insertion — including the closest observations of Saturn and its rings during the entire mission — in our October issue. A



BRIGHT, WISPY STREAKS seen on the steep slopes of this 28-mile-wide crater appear to be ice exposed by landslides. The landslides likely resulted when a small meteoroid slammed into the crater's wall or an impact elsewhere shook the material loose. Many of Phoebe's bigger craters show similar streaks. NASA/JPL/SSI

LOOKING BACK after its closest approach, Cassini captured the crater-rich region around Phoebe's south pole. Sprays of bright material — most likely ice — surround small, young craters and stream down the slopes of large craters. This two-image mosaic was taken from a distance of about 8,000 miles.
NASA/JPL/SSI

BY MARTIN RATCLIFFE AND ALISTER LING

SEPTEMBER 04

Two modest comets cruise the evening sky while the bright planets rule the dawn. As the month comes to a close, the Full Moon lights up the harvest below.

September will make you smile

Steady, transparent skies are a frequent hallmark of early autumn. For observers in much of the Northern Hemisphere, September ranks among the best months of the year — it's common to have good weather on at least half the nights.

This month, all the bright planets either hide behind the Sun or show up in the predawn sky. The faint outer trio — Uranus, Neptune, and Pluto — stay available for evening stargazers. Glowing at magnitude 5.7, Uranus is bright enough to detect without optical aid from the country. With binoculars, it's a snap to find from a suburban backyard. Not far from Uranus, and nearly as easy to locate, lies Vesta, the brightest of all asteroids.

COMET C/2001 Q4 put on an impressive show in May. Although it has faded significantly since then, it still can be seen through a telescope. WALLY PACHOLKA

Two moderately bright comets remain well placed in the evening sky. Although any backyard telescope can reel them in easily throughout the month, it's best to wait until the second week, when the interfering light of the Moon is out of the way. C/2003 K4 (LINEAR) brightens on its inbound trajectory, so that it now surpasses the fading C/2001 Q4 (NEAT), which is on its outbound journey.

For the best views of the comets, develop a defense against dew. The rapidly dropping temperature after sunset at this time of year favors the development of this nefarious destroyer of high-contrast views. For owners of SCTs and refractors, arm yourself with a heated dewcap to keep exposed surfaces above air temperature. A hair dryer will do in a pinch, but slow, gentle heat works best. Even big mirrors can succumb, so think about heating them, too.

The Moon begins September just past its full phase, which it reached on the night of August 29/30. The best dark-sky views will come in the week that brackets New Moon on September 14. Once the Moon hits full phase again late in the month, the Harvest Moon effect takes over. For several nights in a row, the Moon rises slightly later than the previous night. (See "Meteors and moons" on page 62 for details on why this effect takes place.)

If planets are your passion, you'll have to rise before dawn to catch them. In early September, Saturn and Venus breach the eastern horizon together in the wee hours of the night. The two drift apart slowly during the following weeks as Saturn climbs away from the Sun and Venus falls toward it. You might notice that Saturn's rings have started closing up, heading for an edge-on appearance in 2009.

Venus now floats as high in the morning sky as it did in the evening sky this past spring. The crescent Moon passes it on the morning of September 10, which coincidentally makes a great time to spot Mercury at its best. During the next few months, Venus will cruise back toward the horizon and meet with the other bright planets, including a gorgeous pairing with Jupiter on November 5.

Mercury has an impressive morning apparition this month. Keen skywatchers should be up around 5:30 A.M. local daylight time on the 10th to see the speedy messenger skim past Leo's brightest star, Regulus. Through a telescope, try following them into daylight as they separate slowly. Mercury appears the brighter of the two, a yellowish, –0.4-magnitude object compared with the star's bluish, 1.4-magnitude sparkle. During the next few mornings, Mercury brightens further but heads back into the twilight glow.

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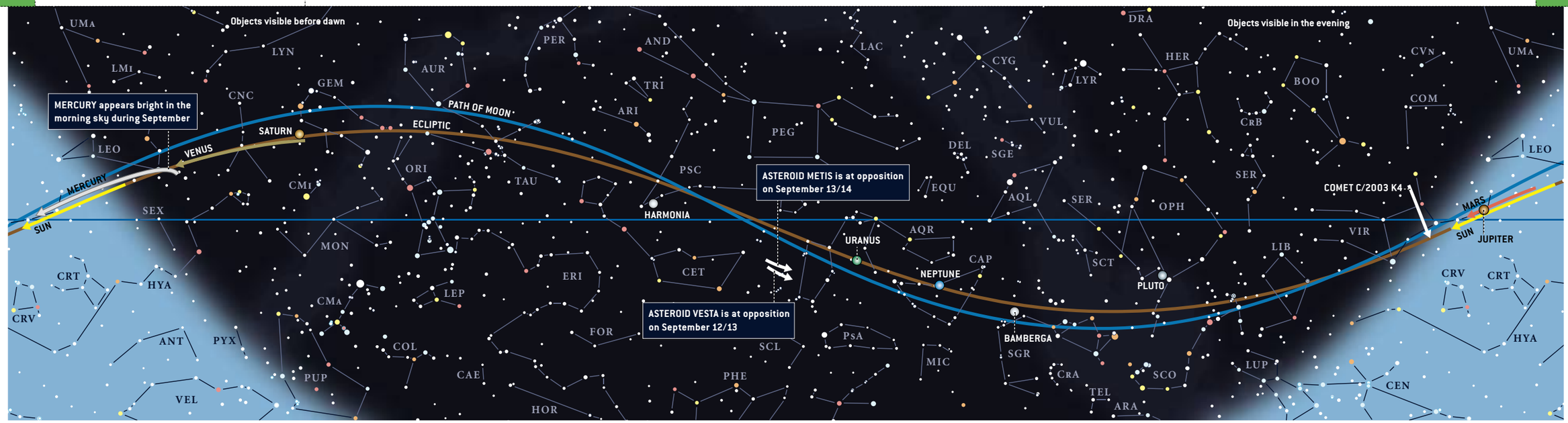
Planets this month

This map unfolds the entire night sky from sunset (at right) until sunrise (at left). Arrows and colored dots show motions and locations of solar system objects during the month.



[15] [14] [13] [12] [11] [10] [09] [08] [07] [06] [05] [04] [03] [02] [01]

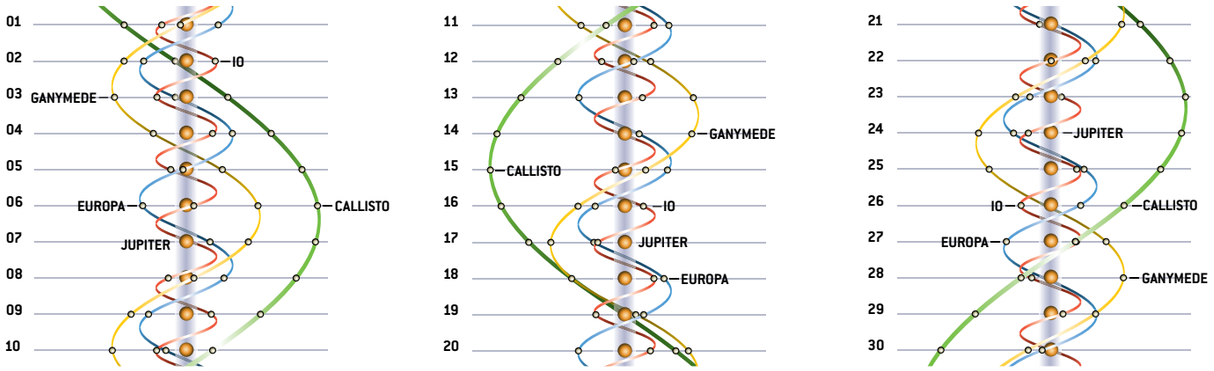
To locate the Moon in the sky, draw a line from the phase shown for the day straight up to the curved blue line.

[30] [29] [28] [27] [26] [25] [24] [23] [22] [21] [20] [19] [18] [17] [16] [15] [14]

PLANETS	MERCURY	MERCURY	VENUS	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Date	September 1	September 15	September 15	September 15	September 1	September 15	September 15	September 15	September 15
Magnitude	1.9	−0.9	−4.2	1.7	−1.7	0.2	5.7	7.9	13.9
Angular Size	9.3"	6.2"	18.1"	3.5"	30.8"	17.4"	3.7"	2.3"	0.1"
Illumination	13%	69%	64%	100%	100%	100%	100%	100%	100%
Distance (AU) from Earth	0.722	1.084	0.924	2.664	6.407	9.545	19.096	29.286	30.880
Distance (AU) from Sun	0.347	0.309	0.722	1.659	5.444	9.048	20.053	30.069	30.846
Right Ascension (2000.0)	9h49.3m	10h33.2m	8h43.5m	11h34.4m	11h42.5m	7h46.4m	22h24.9m	21h01.7m	17h17.2m
Declination (2000.0)	10°48'	10°30'	17°07'	3°49'	3°05'	21°01'	−10°47'	−17°00'	−14°36'

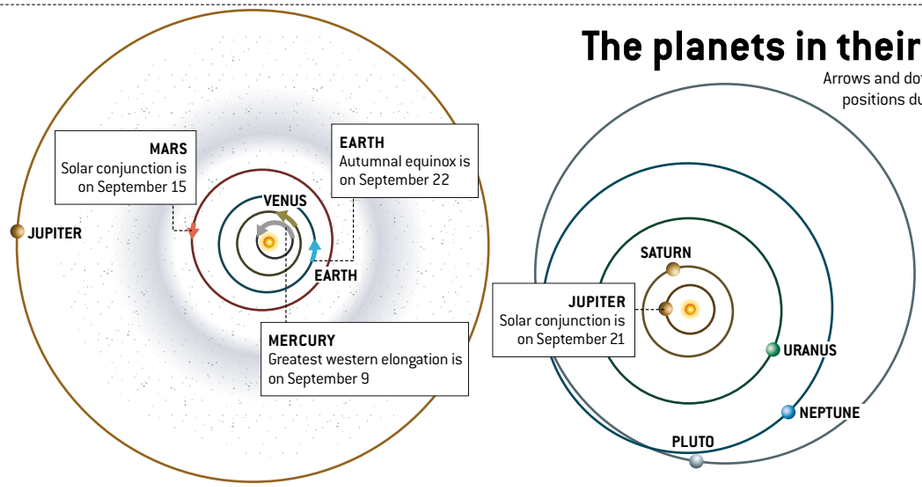
Jupiter's moons

Dots display positions of Galilean satellites at 11 P.M. EDT on date shown. South is at top to match the view in a telescope.



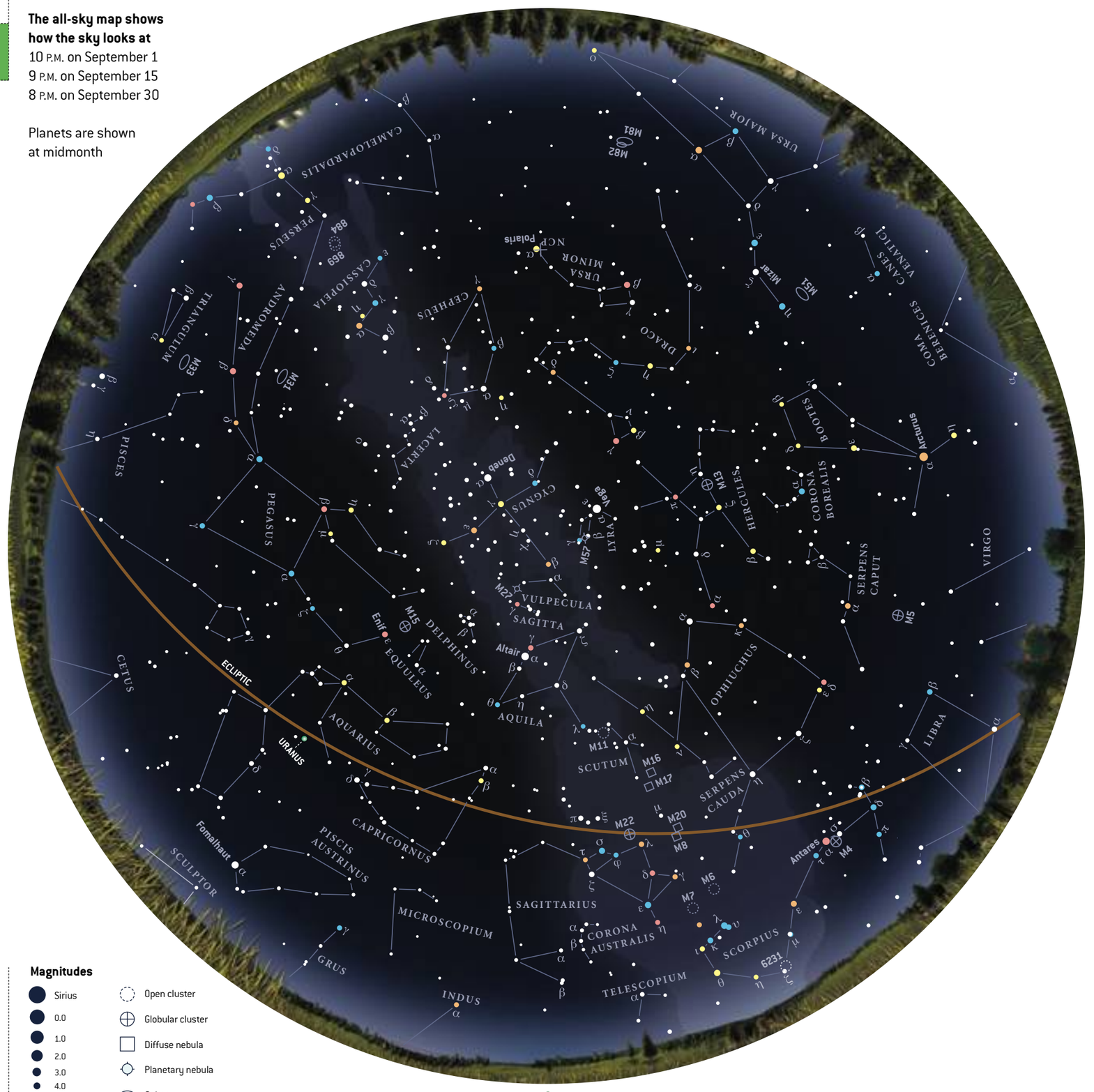
The planets in their orbits

Arrows and dots show planets' positions during the month.



The all-sky map shows how the sky looks at
10 P.M. on September 1
9 P.M. on September 15
8 P.M. on September 30

Planets are shown at midmonth



Magnitudes

- Sirius
- 0.0
- 1.0
- 2.0
- 3.0
- 4.0
- 5.0

- Open cluster
- Globular cluster
- Diffuse nebula
- Planetary nebula
- Galaxy

This map portrays the sky as seen near 35° north latitude at times shown in the upper left corner of the page. Located just outside the map are the four directions: north, south, east, and west. To find stars above your horizon, hold the map overhead and orient it so a direction label matches the direction you're facing. The stars above the map's horizon now match what's in the sky.

september 04

SUN.	MON.	TUES.	WED.	THURS.	FRI.	SAT.
			[01]	[02]	[03]	[04]
[05]	[06]	[07]	[08]	[09]	[10]	[11]
[12]	[13]	[14]	[15]	[16]	[17]	[18]
[19]	[20]	[21]	[22]	[23]	[24]	[25]
[26]	[27]	[28]	[29]	[30]		

01 Venus passes 9° south of Pollux, 10 P.M. EDT

06 Last Quarter Moon is at 11:11 A.M. EDT

07 The Moon is at apogee (251,322 miles from Earth), 10:41 P.M. EDT

09 Mercury is at greatest western elongation (18°), 10 A.M. EDT

The Moon passes 5° north of Saturn, 6 P.M. EDT

10 Mercury passes 0.06° south of Regulus, 1 A.M. EDT

The Moon passes 7° north of Venus, noon EDT

11 Saturn passes 7° south of Pollux, midnight EDT

12 The Moon passes 4° north of Mercury, 9 P.M. EDT

13 Asteroid Ceres is in conjunction with the Sun, 1 A.M. EDT

13 Asteroid Vesta is at opposition, 3 A.M. EDT

14 Asteroid Metis is at opposition, 2 A.M. EDT

New Moon is at 10:29 A.M. EDT

15 Mars is in conjunction with the Sun, 9 A.M. EDT

21 First Quarter Moon is at 11:54 A.M. EDT

Jupiter is in conjunction with the Sun, 8 P.M. EDT

22 Autumnal equinox is at 12:30 P.M. EDT

The Moon is at perigee (229,652 miles from Earth), 4:58 P.M. EDT

24 The Moon passes 5° south of Neptune, 11 A.M. EDT

25 The Moon passes 4° south of Uranus, 11 P.M. EDT

28 Full Moon is at 9:09 A.M. EDT

For definitions of terms, visit www.astronomy.com/glossary

10 REASONS WHY YOU SHOULD BUY A MEADE® SCHMIDT-CASSEGRAIN:

1. Meade Ultra-High Transmission Coatings (UHTC™) Group increases total light transmission and image brightness by nearly 20% over Meade's standard coatings. Objects such as stars, galaxies and nebulae will appear significantly brighter.
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Optical Design	Schmidt-Cassegrain					Maksutov Cassegrain
Aperture	8"	10"	12"	14"	16"	7"
Focal Ratio	f/10	f/10	f/10	f/10	f/10	f/15
Focal Length	2000mm	2500mm	3048mm	3556mm	4064mm	2670mm
Corrector Lens	water white	water white	water white	water white	BK7	BK7
Primary Mirror	Pyrex®	Pyrex®	Pyrex®	Pyrex®	Pyrex®	Pyrex®
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UHTC (option only at time of order)	$175	$235	$295	$350	$495	$150
LPI/Autostar Suite ($149 value)	FREE	FREE	FREE	FREE	FREE	FREE
Shipping & Handling	$105	$145	$215	$265	$385	$125

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- 45° design facilitates a comfortable viewing angle for extended terrestrial viewing and spotting
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Model **#928** for any SCT or refractor telescope focuser that accepts 1.25" O.D. accessories **$42.95** (3.86)
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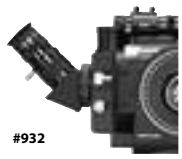
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Barlow Lenses

Series 4000 #140 2x Barlow Lens (1.25")
- Fully color-corrected apochromatic design
- 3-element multi-coated, air-spaced optics
- Double the eyepiece power
- Crisp, high contrast images

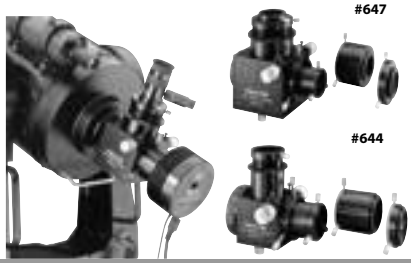
Clear aperture 26mm $79.95 (5.26)

2x Short-Focus Barlow Lens (1.25")
- Double the eyepiece power
- Multi-coated optics
- Use with Meade ETX telescopes
- Insert star diagonal into it for 3x

Clear aperture 26mm $47.95 (4.54)

CCD-Photo-Visual Flip-Mirror Systems

- Flip mirrors greatly facilitate precise centering for CCD imaging
- Both #644 and #647 model Flip Mirrors incorporate a flexure-free one-piece body design, locking threaded helical focuser for the eyepiece, precision-polished UHTC-coated mirror diagonal flats, precision X/Y adjustment mechanism for the diagonal mirror with locks for precise centering, and multiple rotating adapters for T-thread and 1.25" O.D. camera attachment
- **#644 Flip Mirror System** accepts 1.25" O.D. eyepiece only and has a clear aperture of 22mm; use with small to medium size chip CCD cameras **$149.95** (7.02)
- **#647 Flip Mirror System** accepts 1.25" and 2" O.D. eyepieces and has a clear aperture of 40mm; use with medium to large size chip CCD cameras **$249.95** (8.49)



#647

#644

ETX® Hard Carrying Cases

- Convenient for storage or travel
- Hard plastic box lined with die-cut foam
- Multiple storage areas for accessories

#774 for ETX-90™ models **$99.95** (8.58)
#776 for ETX-105™ models **$99.95** (8.58)
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2" Diagonal Mirrors with UHTC™

- Precision-polished flat mirror
- UHTC-coated (95%+ reflectivity)
- Includes 1.25" eyepiece adapter
- **#929** threads on to the rear cell of most SCTs **$119.95** (6.85)
- **#930** slides into any 2" focuser **$119.95** (6.85)

Series 4000 8mm-24mm Zoom Eyepiece

- 7-element, fully multi-coated optics (1.25")
- 55˚ apparent field of view at 8mm
- Internal zoom design, with graduated scale in 1mm units
- Performance is fully consistent with the finest fixed-focal length eyepieces

$219.95 (6.38)

9x63 Roof Prism Binocular

- Large 63mm aperture fully multi-coated objective lenses and BAK-4 roof prisms deliver bright images, perfect for surveying the constellations and observing nebulae and comets
- Multi-coated long eye-relief, wide apparent field eye-pieces are fitted with comfortable rubber eyecups
- The lightweight, rubber-coated body is perfectly sculpted for comfortable hand-held use

$99.00 (9.33)

Filters

Series 4000 Photo-Visual Color Filters
- Large, 26mm aperture, anti-reflection coated
- Filter is pure crown glass, dyed-in-the-mass
- Threads onto most 1.25" eyepieces
- Increases contrast of fine planetary features

Set #1: #12, #23A, #58, #80A **$49.95** (4.54)
Set #2: #11, #25A, #47, #82A **$49.95** (4.54)
Set #3: #8, #21, #38A, #56 **$49.95** (4.54)

** Individual filters may be purchased separately for **$14.95** (2.73)*

Series 4000 Moon Filter
- Reduces glare and irradiation during lunar observing
- 13% uniform light transmission across the visual spectrum
- Threads into 1.25" barrels

$16.95 (2.73)

#911B

Series 4000 Nebular Filters
- Premium multi-layer interference filters
- Broadband filters are great for all types of deep sky observing, and will block most forms of light pollution

#908B

#908B: Threads into 1.25" eyepieces, 26mm diameter **$79.95** (4.54)
#911B: Threads on to the rear cell of most SCTs, 36mm diameter **$99.95** (5.26)

- Narrowband filters yield spectacular high contrast views of faint nebulae, and work in heavily light-polluted conditions

#908N: Threads into 1.25" eyepieces, 26mm diameter **$89.95** (4.54)
#911N: Threads on to the rear cell of most SCTs, 36mm diameter **$119.95** (5.26)

Series 4000 Oxygen-III Filters

#911X

- Exclusive Meade 60-layer interference coating gives incredible O-III transmission performance
- Observe diffuse emission, planetary nebulae and supernova remnants
- Isolate the 496nm and 501nm O-III lines

#908X

#908X: Threads into 1.25" eyepieces, 26mm **$99.95** (4.54)
#911X: Threads on to the rear cell of most SCTs, 36mm diameter **$149.95** (5.26)

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- Equatorial wedge for 8" LX90 **$169.95** (20.00)
- Standard equatorial wedge: use with Meade's 7" MAK and 8" SCT LX-series telescopes **$149.95** (20.00)
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Series 4000 Focal Reducers

f/6.3 Focal Reducer/Field Flattener

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- Threads onto the rear cell of most SCTs
- Converts f/10 scopes to f/6.3 or f/6.3 SCTs to f/4
- Visual field is increased by 56%
- Reduces exposure times by about 50%

41mm clear aperture **$129.95** (5.26)

f/3.3 CCD Focal Reducer/Field Flattener

- 3-element, multi-coated
- Increased edge-of-field resolution and color correction
- Reduces CCD exposure times by up to 80%
- Threads onto the rear cell of most SCTs
- Variable T-adapter (included): f/3 and f/5 on f/10, 1.9 and f/3.2 on f/6.3
- Not for visual applications

41mm clear aperture **$149.95** (5.26)

Vibration Isolation Pads for Tripods

- Dramatically reduces vibration-damping time
- Recommended by top astronomers for any telescope

Set of 3 **$49.95** (7.02)

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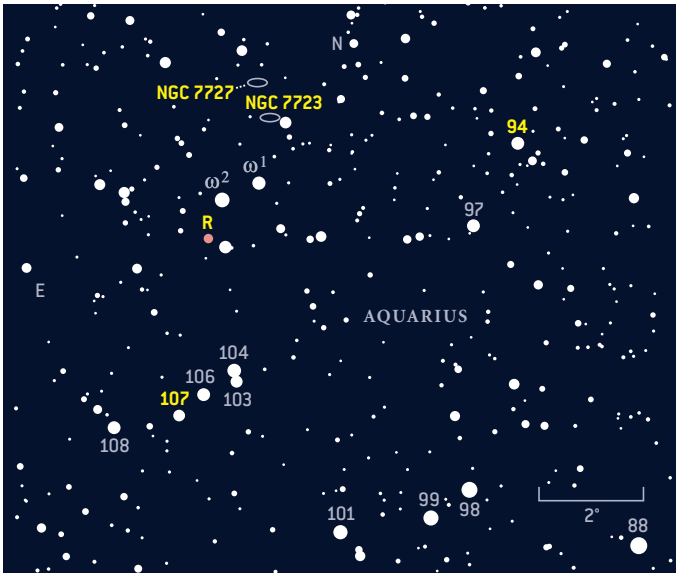
- **#547 AC adapter** for LX200™GPS, LXD55, LXD75™ series telescopes **$69.95** (7.02)
- **#546 AC adapter** for ETX-70™, DS™-2000, NGC series telescopes **$19.95** (2.73)

THE DEEP SKY

A bloated variable star joins a profusion of multi-star systems in the southern reaches of the Water-bearer, which also holds its share of distant island universes.



Water in a dry sky

As creatures of habit, we inevitably turn our eyes toward the east to see what's new coming over the horizon. As you can see on the circular foldout map, the Great Square of Pegasus greets us with its bold outline on September evenings. Heading south, a bit to the lower right, we pass through the Circlet of Pisces into the liquid world of Aquarius the Water-bearer. You've gone too far if you land on the bright star Fomalhaut, twinkling close to the horizon.

If you're viewing from your backyard, use binoculars to trace a series of widely spaced triplets that defines the southern portion of Aquarius. On the left edge of the sweep, the triplet chaired by Omega[1] (ω^1) and Omega[2] (ω^2) Aquarii sports a fiery orange companion: the long-period variable star R Aquarii. Currently, this variable glows at its brightest, about magnitude 6.5. Compare its brightness with the 5.3-magnitude star just to the west (right) and especially with the 6.2-magnitude star to the southeast (lower left). Congratulations — you've taken the first step in estimating the brightness of a variable star.

Now ask yourself: Does R Aquarii look the same, a bit brighter, or a bit fainter than the comparison stars? You can make this simple and quick estimate useful scientifically by recording the time of your observation and sending the estimate to the American Association of Variable Star Observers (AAVSO). Last summer, R Aqr crested a full magnitude brighter than its typical maximum. What will it do this year?

You can download a free comparison star chart from *www.aavso.org*. At the top left, where you see "Pick a star," click on "Chart," type in "R Aqr," and click "Submit." If you check R Aqr every couple of weeks through the end of the year, you'll notice it growing dimmer and redder.

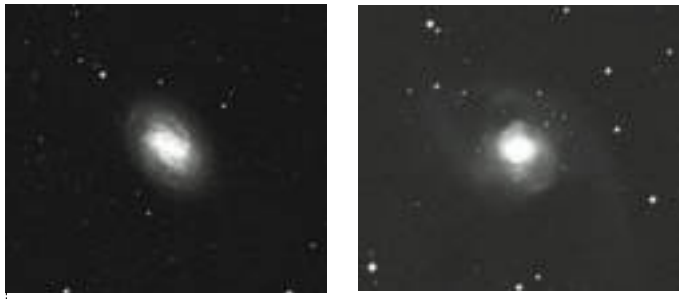
Through a telescope, you often can find stars nestled close together. About 5° west of Omega lies 94 Aqr, a line-of-sight pair. At low power, it looks like a single star, although you might not be able to focus it to a point. Bump the magnification up to 100x to see it split into an unequal pair.

Some 4° south of Omega lies a slightly tighter duo that's also closer in brightness. The separation between the two stars of 107 Aqr is 7", about twice the gap between the famous Double-Double components in Lyra.

Into the distance

Between 1° and 2° north of Omega[1] Aqr — and about 100 million light-years farther away — lie the galaxies NGC 7723 and NGC 7727. NGC is short for *New General Catalogue of Nebulae and Clusters of Stars*, which was compiled in the 1880s and is the master reference of all the deep-sky discoveries of the great visual observers. Up until John Dryer corralled several smaller catalogs into a cross-referenced, unified whole, the state of the fuzzy sky was filled with positional discrepancies and multiple names.

At magnitudes of 11.2 and 10.6, respectively, NGC 7723 and NGC 7727 glow fainter than the best and brightest the sky has to offer. To see them through a 4-inch telescope, you should be out under a dark country sky during the second week of September, when the Moon is out of the sky. Increase the magnification to 100x or so to darken the background sky and increase the size of the small fuzzies.



SPIRAL GALAXIES NGC 7723 (left) and NGC 7727 (right) in Aquarius the Water-bearer make tempting targets for observers with 6-inch or larger telescopes. DIGITIZED SKY SURVEY

Martin Ratcliffe *is former president of the International Planetarium Society.* **Alister Ling** *is a meteorologist for Environment Canada.*

THE PLANETS

While the faint planets congregate in the evening sky, the brighter ones dominate the morning — capped by Mercury making one of its best appearances of the year.

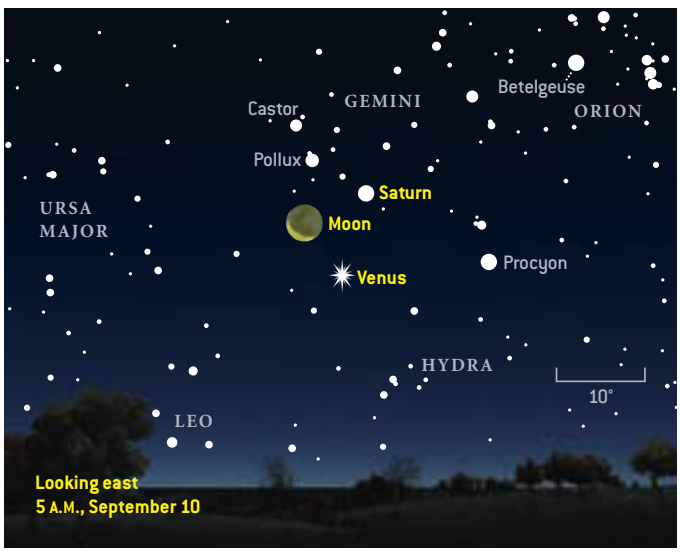
BRILLIANT VENUS hugs the horizon while Saturn glows second brightest in this view from 1977. Leo's brightest star, Regulus, lies between the two. The two planets once again appear near each other in September. FRED ESPENAK

Two gas-giant planets, Uranus and Neptune, occupy the evening scene, and you can spot them with binoculars if you're observant. By 11 P.M. local daylight time in early September, **Neptune** lies due south in Capricornus. This constellation appears rather faint, so viewing from the city will render most of its stars invisible. Binoculars will help you locate Neptune easily, however, because the planet lies close to the 4th-magnitude star Theta (θ) Capricorni.

Glowing at magnitude 7.8, Neptune stands less than 1° northwest of Theta Cap in early September. As the weeks pass, Neptune moves westward, ending the month 1.2° west of the star. The blue-gray disk of Neptune appears tiny, 2.3" across, requiring at least a 4-inch telescope to discern.

Uranus proves much easier to view than Neptune because it glows brighter and displays a larger disk in a scope. This happens despite the fact the two planets have nearly the same physical diameter. The culprit — distance. Uranus lies only two-thirds as far from Earth as Neptune does.

Uranus resides in central Aquarius, near the star Sigma (σ) Aquarii. As September opens, the planet lies 0.9° west of this 4.8-magnitude star. Uranus glows a little fainter, at magnitude 5.7, although it's still an easy target for binocular users. Those blessed with an inky-black sky should be able to spot it with the naked eye. Uranus reached opposition during the last days of August, so it remains due south around local midnight in early September. Its nightly motion against the background stars carries it westward until late October, when it resumes its normal easterly path.



An entourage of bright planets can be found in the sky before dawn. An exquisite pairing of Saturn and Venus dominates the morning scene. On September 1, both planets rise some 4 hours before the Sun and stand high in the east as twilight approaches. Just 2° separate the pair. Venus outshines Saturn by more than fifty times, with Venus at magnitude –4.2 and Saturn at magnitude 0.2. Saturn sits 7° south of the star Pollux, which joins with Castor to form a second familiar pair in the constellation Gemini the Twins.

Venus begins to drop away from Saturn at a rate of almost 1° per day. A waning crescent Moon passes 7° north of Venus on September 10, forming an attractive sight. Through a telescope that morning, Venus appears 19" across and shows a 62-percent-lit phase, a marked contrast to the 17-percent-lit lunar crescent. Four days later, on September 14, Venus lies 2.5° south of the Beehive star cluster (M44) in Cancer the Crab. For the remainder of September, the "morning star" approaches Regulus in Leo the Lion, ending the month 4° from this 1.4-magnitude star. The gap tightens significantly in the first few days of October.

Saturn remains in Gemini throughout September, nearly due south of that famous pair of 1st-magnitude stars, Castor and Pollux. The planet rises an hour after midnight by the end of the month and climbs high enough by twilight's start to offer excellent views through a telescope. Saturn's disk measures 17" across this month, while the ring system spans 40" and tilts its southern face in our direction.

A small telescope also reveals several saturnian moons. The brightest is Titan, which glows at magnitude 8.3. You can find it due north of Saturn on September 9 and due south on the 17th. On the morning of the 16th, Titan and the variable moon Iapetus lie close to each other, with the latter glowing at 11th magnitude. Iapetus remains one of the most intriguing moons in the solar system, varying in brightness by a factor of five during the course of its orbit. At greatest western elongation, it glows at magnitude 10.1 (this occurred on August 29). Six weeks later, on October 9, it reaches greatest eastern elongation and appears much dimmer at magnitude 11.9.

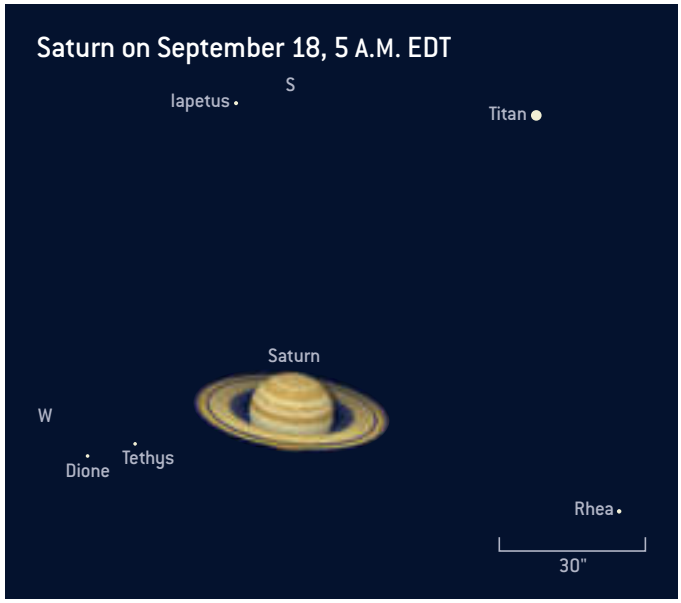
On September 9, a crescent Moon hangs above three bright planets: Saturn, Venus, and, hugging the horizon, Mercury. On that morning, **Mercury** reaches greatest elongation, standing 18° west of the Sun.

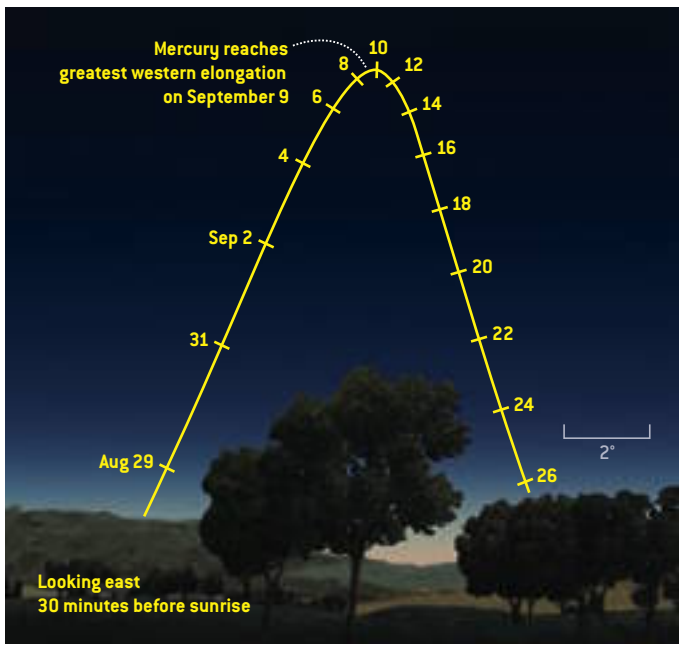
This ranks among the best of Mercury's 2004 morning apparitions. On September 10, the same day the crescent Moon sits near Venus, Mercury lies close to the bright star Regulus in Leo. Only 0.3° separates the two, placing both objects within the same telescopic field of view at medium power. The planet displays a 7"-diameter disk that's half-lit.

Mercury brightens during September, surpassing magnitude 0.0 on the 8th, while its diminutive disk shrinks as the planet falls back toward the Sun. On September 13, the planet stands 5° to the upper right of a very thin crescent Moon. By the 20th, Mercury shines at magnitude –1.1 and lies very low in the eastern predawn sky. It disappears from view soon afterward.

Neither **Mars** nor **Jupiter** can be seen this month. They pass behind the Sun within a week of each other in mid-September. Jupiter returns to view in October while Mars waits until November.

The autumnal equinox occurs at 12:30 P.M. EDT on September 22, marking the moment when the Sun crosses the celestial equator heading southward. The Sun then lies in the constellation Virgo.





METEORS AND MOONS

Although no major meteor showers grace September's sky, the month offers great opportunities to view both an old Moon and the Harvest Moon.

THE 1999 HARVEST MOON rises above the Garden of the Gods Park in Colorado Springs, Colorado. BRUCE ELLIOTT

A September lull

No significant meteor shower takes place in September. One minor shower, the Delta Aurigids, remains active for most of the month. Rates are low, however, with less than five meteors per hour expected even when the radiant is high in the sky. Even worse, the waning crescent Moon sheds some unwanted light at the shower's peak on September 9. A weaker, secondary peak occurs around the 23rd, with perhaps brighter meteors than the earlier peak.

Two intriguing Moons

Instead of narrowing our focus to an individual lunar feature, this month we look at the big picture. Mid-September offers a great opportunity to spot an exceedingly thin lunar crescent, while the end of the month brings with it the annual Harvest Moon.

The term "old Moon" refers to the last stages of the lunar month, just before the waning crescent Moon gets reborn at New Moon. The morning sky in September proves conducive to seeing an old Moon because the ecliptic — the apparent path of the Sun across the sky that the Moon also follows closely — inclines steeply to the eastern horizon for observers throughout the Northern Hemisphere.

September's New Moon occurs at 10:29 A.M. EDT on September 14. This means that from the East Coast of the United States on the morning of the 13th, the crescent Moon is just 28 hours from its new phase. It lies 5° to the lower left of Mercury and rises about 75 minutes before the Sun and just 12 minutes after Mercury.

Seeing such an old Moon requires a special set of observing conditions — as well as good timing. You'll need both an unobstructed eastern horizon and excellent atmospheric transparency. The slightest bit of haze can block the narrow crescent from view.

Observers living farther to the west will have an increasingly difficult time spotting the lunar crescent. On the West Coast, the Moon is just 25 hours from its new phase and has slid even closer to the Sun. By the time the Moon pokes above the horizon, it lies 6° to the lower left of Mercury and will be very difficult to see. However, the potentially clear desert air of the southwestern United States should increase the odds.

The ecliptic also plays the key role in September's other major lunar event. The Harvest Moon is just another name for the Full Moon occurring nearest the autumnal equinox. It gets its name because the Moon rises only a bit later each succeeding night, and the bright light above helps farmers bringing in their crops.

For the Harvest Moon, the ecliptic has an opposite effect from what it has at old Moon. When night falls in September, the ecliptic makes a shallow angle to the eastern horizon. Imagine the Moon just clearing the horizon on the night it is full (September 28 this year). At the same time on the next night, the Moon doesn't lie very far below the horizon because it has been traveling nearly along the ecliptic. That means the Moon doesn't rise that much later than it did on the previous night, an effect that persists for several days.

A SLIM CRESCENT MOON rises shortly before the Sun. Mark September 13 on your calendar for a chance to see a similarly old Moon. JERRY SCHAD

COMETS AND ASTEROIDS

Although the comet show may be winding down, a few evening comets remain within reach of backyard observers. By the time midnight rolls around, the brightest asteroid appears at its peak.

Evening comets galore

Comet C/2003 K4 (LINEAR) continues to brighten into easy binocular range. Expected to glow around 6th magnitude, this dirty snowball should show a central condensation surrounded by a fading halo. Binoculars should reveal the comet as a fuzzy "star" to the lower left of 3rd-magnitude Epsilon (ε) Virginis, which lies below the bright orange star Arcturus in the western sky as darkness falls.

You should try to find this comet about an hour after the Sun sets during the first two weeks of September. Because the comet is heading behind the Sun from our point of view, it will set by mid-evening and be out of sight after mid-September. C/2003 K4 will reappear as a bright morning comet for observers in the Southern Hemisphere during early November.

Nicely placed from the Northern Hemisphere, Comet C/2001 Q4 (NEAT) continues to sail across the back of Draco the Dragon. Although the comet is well past its spring peak, it still compares favorably with the brighter galaxies of the Messier catalog. Because the comet lies so far north, it remains circumpolar throughout most of the United States, meaning it stays above the horizon all night.

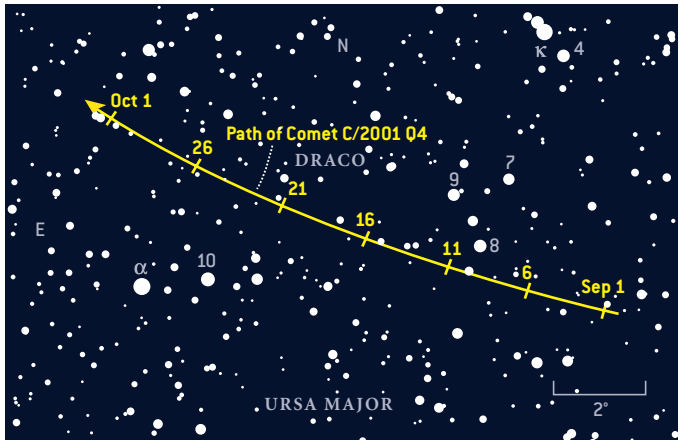
During the first half of September, observe Q4 in the early evening hours, when the Moon's interfering glow remains out of the sky. During the second half of the month, when the Moon has moved to the evening sky, switch to a predawn observing session.

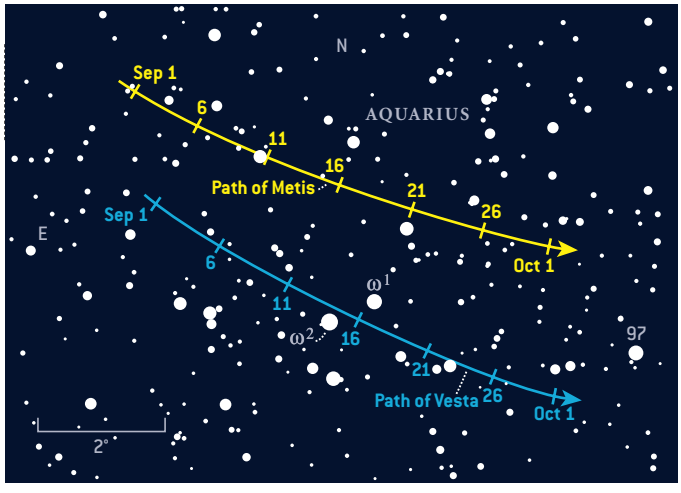
Deep-sky observers and astro-imagers will want to keep their eyes out for a third comet. C/2003 T3 (Tabur) will be in conjunction with the spiral galaxy NGC 3198 in southern Ursa Major on the morning of September 17. Both the comet and the galaxy glow around 11th magnitude.

A trio of asteroids

When an object lies due south around local midnight, it also lies opposite the Sun in our sky. That's why astronomers use the term opposition to describe this configuration. Typically, opposition also means that the object lies closest to Earth and thus appears at its brightest. This holds true in September for the fourth asteroid to be discovered: 4 Vesta.

Vesta is a large chunk of rock some 330 miles (530 kilometers) in diameter. Its surface must consist of a really light-colored soil because it reflects light some seven times better than the Moon's darker regolith. All these factors combine to give Vesta a glow of magnitude 6.1 when it reaches opposition on the night of September 12/13, making it just visible to the naked eye from a dark site. The brightest stars in the area, Omega[1] (ω[1]) and Omega[2] (ω[2]) Aquarii, lie to the right of the tip of Cetus the Whale's snout.





Use the chart above to zero in on Vesta. The chart shows stars down to magnitude 9.5, so the asteroid should be easy to pick out through binoculars. Its nightly motion should be easy to track, too. If you want a small-scope challenge, try finding the asteroid 9 Metis. This smaller object parallels Vesta's course 2° to the north. Metis reaches opposition a night after Vesta, when it glows at magnitude 9.1, just 6 percent as bright as its companion.

Perhaps the most intriguing asteroid this month is 4179 Toutatis, named after a god of the Gauls and made famous in the comic strip *Asterix*. As its number implies, this Earth-crossing object was discovered fairly recently. It glows faintly except during its rare, close passages by Earth — one of which occurs late this month. Watch for detailed finder charts in the October issue.

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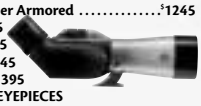

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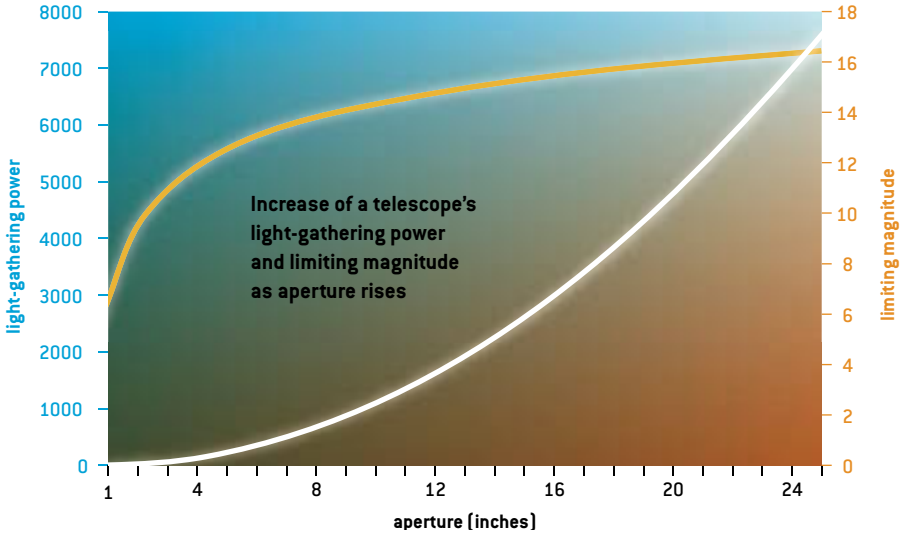
Aperture fever, Leonid meteor storms, and telescope sizes

APERTURE FEVER

I have quickly come to find out that my 3.5-inch refractor is completely useless on faint objects, such as nebulae, galaxies, globular clusters, and comets. Will they be well within my reach with an 8-inch telescope? — **SCOTT TIERCE,** DALLAS, GEORGIA



GREATER APERTURE means more light-gathering power. The white curve shows how a telescope's power rises over that of the young human eye: nearly 120 times for a 3-inch aperture, more than 1,000 times for a 9-inch aperture. The orange curve tracks the magnitude of the faintest stars visible with each aperture, starting with the human eye at magnitude 6.5. How larger apertures improve the view of extended objects, like galaxies and nebulae, is more complex, but the same general principle applies. *ASTRONOMY:* ROEN KELLY

You have already learned one of the fundamental lessons about telescopes: Size rules. The larger the diameter of the telescope (the kind of scope doesn't matter), the more light it will collect. A 3.5-inch refractor is a good scope for planets, the Moon, and double stars. I know because I own a 4-inch refractor, and I wouldn't part with it for love or money. But this size telescope is a bit small for deep-sky objects such as nebulae and galaxies. Things improve if you can get away from city lights and observe under a really dark sky, but size remains a limiting factor. An 8-inch telescope (again, it doesn't matter what type) will move you into a new dimension of viewing. The objects you now observe with your 3.5-inch scope will show much more detail in an 8-inch scope, and they'll be quite a bit brighter.

Let me mention a specific note about observing galaxies. These objects are quite low in surface brightness, so you'll want to observe from a dark site to increase their contrast with the sky.

And here's another thing to keep in mind: If you stay interested in observing, someday you'll probably want an even larger scope. This malady among amateur astronomers is known as "aperture fever," and, yes, I'm infected. I started many years ago with a 2.4-inch telescope of good quality. I now own a 4-inch refractor and a 12-inch Schmidt-Cassegrain, and I dream of owning a 20-inch telescope. — **MICHAEL E. BAKICH,** ASSOCIATE EDITOR

LEONIDS OF 1833

I recently found out about a great meteor shower that occurred on November 14, 1833. It was so bright that Native Americans camped on the Great Plains were awoken by the flashes of meteors. What actually caused this great event, and is there anything today that compares to it?
— **BRYAN J. STANLEY,** MADISON, WISCONSIN

This event was the Leonid meteor shower, which consists of ice and dust "conglomerates" ejected from Comet Tempel-Tuttle as it passes through the inner solar system. Normally an annual shower with rates of only 20 or so meteors per hour, the Leonids have the potential to outburst into spectacular meteor storms at roughly 33-year intervals, which is the amount of time it takes Comet Tempel-Tuttle to orbit the Sun. The last storm was in 2002, and recent computer modeling indicates there will be no further Leonid storms until the next century.

Based on what I know, only the Leonid storm of 1966 possibly matched the outburst of 1833. I didn't see it personally, but some of those who witnessed the event likened it to being on the outside of the starship *Enterprise* while moving at warp speed, watching the stars streak by. Even so, I don't think any meteor shower observed since can compare to the one in 1833. In a very real sense, it gave birth to meteor science. It was so spectacular that astronomers seriously began looking at what causes meteor showers, which, of course, led them to the connection with comets. Also, the written descriptions of

Send your questions via e-mail to: askastro@astronomy.com; or write to: Ask Astro, P. O. Box 1612, Waukesha, WI 53187.
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METEORS STREAK from the constellation Leo every November, but some years are much better than others. Italian astrophotographer Russo Massimo imaged the 2001 Leonid storm from Australia, combining five 10-minute exposures to produce this montage. *Inset:* Karl Jauslin's woodcut, first published in 1888, has become the most famous image of a meteor shower. Based on the boyhood memory of Jauslin's patron, the woodcut was created more than 50 years after the 1833 Leonid storm. Nevertheless, astronomers today believe it gives a reasonably accurate impression of the event. RUSSO MASSIMO; *INSET:* ARMAGH OBSERVATORY

the event are so dramatic that one cannot but believe that the sky looked like it was coming apart that morning back in November of 1833. Here's one eyewitness report, cited by George Chambers in his 1889 astronomy handbook:

"I heard a faint voice near the door, calling my name. . . . Beseeching me to rise, and saying 'O my God, the world is on fire!' I then opened the door. . . . Upwards of 100 lay prostrate on the ground . . . with their hands raised, imploring God to save the world and them. The scene was truly awful; for never did rain fall much thicker than the meteors fell towards the Earth; east, west, north and south, it was the same." **— BILL COOKE,** MARSHALL SPACE FLIGHT CENTER

HOW SMALL IS SMALL?

Many articles and books on observing refer to small, medium, and large telescopes, but what are the borderlines in objective size that define small, medium, and large? — EDWARD C. DAY, EAST MONTPELIER CENTER, VERMONT

I can't speak for every reference to small, medium, or large telescopes, but here at *Astronomy*, when we refer to a "small" scope we specifically mean a telescope with an aperture less than 4 inches. The type of scope doesn't matter, and neither does the quality. Many small telescopes manufactured today are high-quality instruments that I am proud to use.

"Medium" size telescopes have apertures from 4 to 10 inches in diameter. This category contains the most popular telescopes used by amateur astronomers, a large percentage of which are 8-inch Schmidt-Cassegrain telescopes.

Finally, any telescope that uses a lens or mirror larger than 10 inches across we designate as "large." More large telescopes are in use today than ever before, due in large part to the "Dobsonian revolution." Newtonian reflectors coupled to relatively simple altitude-azimuth Dobsonian mounts dramatically reduced the price and weight of large telescopes from what they would have cost had they been attached to a motor-driven, equatorial mount. **— MICHAEL E. BAKICH,** ASSOCIATE EDITOR

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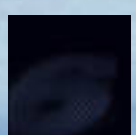

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Trekking the autumn sky

As the long days of summer recede, the sky darkens earlier each evening — it's a good time to tour the sky. But which are the season's must-see stars, clusters, nebulae, and galaxies? Here are my favorites that lie within range of binoculars and small telescopes. ‹ There's no better place to begin than the Andromeda Galaxy **(M31)** [tour stop 1].

This near twin of our home galaxy passes high overhead around 11 P.M. in mid-autumn. (See the map on page 72 for dates and times.) About 2.6 million light-years away, M31 is the most distant object visible to the naked eye (in light-polluted areas, however, you'll need binoculars to pick it out). To find it, face south and start at the top left corner of the Square of Pegasus, hop two stars to the left, then two up. Through binoculars, the Andromeda Galaxy appears as an elongated patch of mist perhaps two or three times wider than a Full Moon. As with all nebulous objects, how far you can trace the outer regions depends on the clarity and darkness of your sky. Under excellent conditions, you may be able to detect dark lanes of dust in M31's spiral arms using binoculars or a telescope, although you will not resolve any individual stars. With a telescope, use your lowest-magnification eyepiece to have the widest field of view.

While looking at M31, small-telescope users should try to see its two companion galaxies. **M32** [2] appears as a fuzzy 8th-magnitude star one Moon-diameter south of M31's core. The second, known both as **M110** and **NGC 205** [3], lies on the other side of M31, about two Moon-diameters from the center. It's tougher to spot, being larger and more diffuse.

The constellation Andromeda is home to perhaps the finest colored double star in the fall sky, **Gamma (γ) Andromedae** [4]. Apertures as small as 2.4 inches (60 millimeters) will divide it into an orange and blue-green pair of 2nd and 5th magnitude, providing an attractive color contrast. On the opposite side of the constellation lies one of Andromeda's often-overlooked treasures, planetary nebula **NGC 7662** [5], which is known as the Blue Snowball. Even a small telescope shows it as a fuzzy blue-green star about as big as Mars, and with magnifications of 100x or so, its north-south elliptical shape may be discernible.

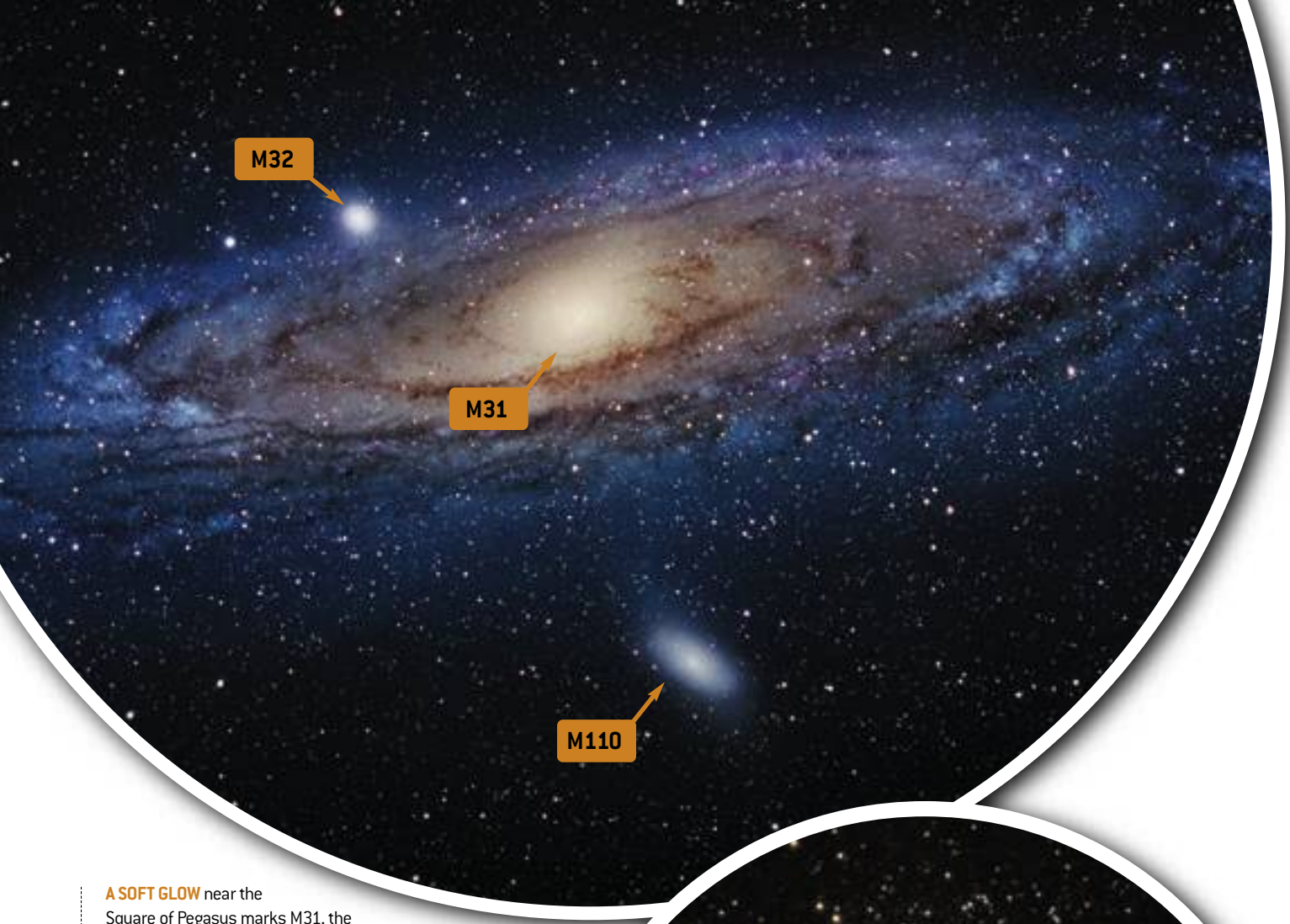
THE BLUE SNOWBALL (NGC 7662) is a cloud of gas shed by a star late in life. Astronomers call such objects "planetary nebulae" because they loosely resemble the dim, distant planets Uranus and Neptune. ADAM BLOCK/NOAO/AURA/NSF

Drop south to Pegasus for the finest globular cluster in the autumn sky, **M15** [6]. It's bright enough to be detectable with the naked eye under the clearest skies and shows up through binoculars as a softly rounded glow. Small telescopes will reveal a brighter center, but to resolve individual stars, you'll need apertures of at least 4 inches (100mm), which is no surprise as this cluster lies some 34,000 light-years distant. Compare it with **M2** [7], another globular 13° due south in Aquarius. M2 appears slightly fainter and smaller than M15, a result of its being 10 percent farther away.

Aquarius boasts two famous planetary nebulae, although neither are particularly easy to spot. **NGC 7009** [8] is popularly known as the Saturn Nebula because it has two wing-like extensions that resemble the rings of Saturn when seen through large apertures or on photographs. Owners of small telescopes can see the nebula's blue-green central disk, coincidentally similar in size to the globe of Saturn. Aquarius also contains the planetary nebula of largest apparent size, **NGC 7293** [9], known as the Helix. It covers half the apparent diameter of the Moon, due to the fact that it lies only 300 light-years away. In photographs, it makes a colorful flower-like ring, but binoculars and low-power telescopes show it as a circular misty patch. The Helix needs clear, dark nights to be seen well.

In the center of Aquarius lies a group of four stars marking the Water Jar. In the middle is **Zeta (ζ) Aquarii** [10], a binary star with an orbital period of 760 years. Currently, these twin 4th-magnitude stars can be split by a 3-inch (75mm) telescope with sufficient magnification, but their orbit is moving them apart gradually. Keep an eye on this pair in coming years.

Scan left from the Water Jar of Aquarius and find another distinctive feature, the Circlet of Pisces, directly beneath the Square of Pegasus. The Circlet consists of a ring of seven stars. The leftmost, known both as **19 Piscium** or **TX Piscium** [11], is strongly orange through binoculars. It



A SOFT GLOW near the Square of Pegasus marks M31, the Andromeda Galaxy. This spiral galaxy (and its two satellite companions, M32 and M110) make a good jump off point for exploring autumn's deep-sky universe. TONY AND DAPHNE HALLAS

varies in brightness between magnitudes 4.8 and 5.2 (a change of nearly 50 percent) with no set period. Follow its fluctuations by comparing it to nearby stars.

Next is a binary star with an orbital period longer than 900 years — **Alpha** (α) **Piscium** [12], also known as Alrescha. It consists of white stars of 4th and 5th magnitude. Currently, the two are moving closer together as seen from Earth and probably require apertures of 4 inches (100mm) to divide them, although a good 3-inch scope may do the job. This pair will challenge you.

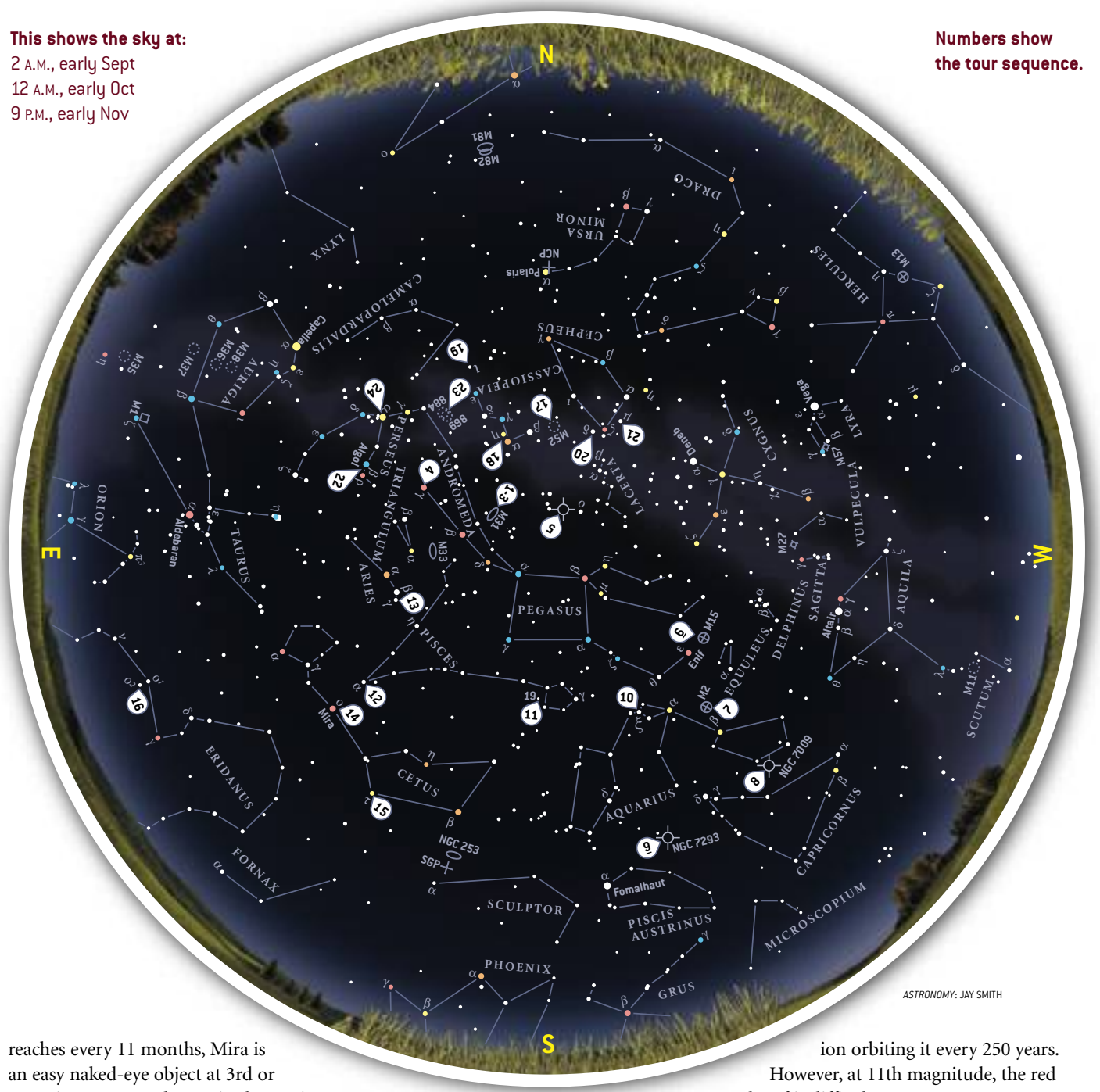
For an easier double, look north to Aries, a constellation with little more than a crooked line of three stars. The faintest and rightmost of the three, **Gamma** (γ) **Arietis** [13], is a neatly matched pair of white, 5th-magnitude stars. Discovered by Robert Hooke in 1664, it was one of the first known double stars.

Drop south again to find **Omicron** (ο) **Ceti** [14], or Mira (meaning "amazing" or "wonderful"), named for its now-you-see-it, now-you-don't behavior. Mira is a red giant, hundreds of times larger than the Sun. Like many red giants, it swells and contracts in size, changing brightness as it goes. At its brightest, which it

GLOBULAR CLUSTER M15 lies near the naked-eye star Enif in Pegasus at the end of the horse's nose. This "star city" is nearly as old — 12 billion years — as the universe and lies about 40,000 light-years away. ADAM BLOCK/NOAO/AURA/NSF

This shows the sky at:
2 A.M., early Sept
12 A.M., early Oct
9 P.M., early Nov

Numbers show the tour sequence.



ASTRONOMY: JAY SMITH

reaches every 11 months, Mira is an easy naked-eye object at 3rd or sometimes even 2nd magnitude. But it spends most of its time below the naked-eye threshold. Mira was the first periodic variable star discovered.

Whereas Mira is vastly larger and cooler than the Sun, another star in Cetus is notable for its similarity to the Sun: **Tau** (τ) **Ceti** [15], which shines at magnitude 3.5. At a distance of 11.9 light-years, it is the closest Sun-like star and was one of the first targets of efforts to listen for radio messages from alien civilizations. As yet, we don't know whether it possesses planets like Earth, but we can gaze at its yellow-white light and wonder.

In the northern reaches of the neighboring constellation Eridanus lies **Omicron^2** (o^2) **Eridani** [16], also known as 40 Eridani. This is a triple star with the most easily seen example of a white dwarf. A white dwarf is a small, dense remnant left behind when a star such as the Sun dies. Omicron^2 Eridani's primary is an ordinary, yellow, 4th-magnitude star, but small telescopes show a wide, 9th-magnitude companion — the white dwarf. Oddly enough, the white dwarf itself has a *red* dwarf companion orbiting it every 250 years.

However, at 11th magnitude, the red dwarf is difficult to spot.

Turn your gaze back overhead, to the familiar W shape of Cassiopeia. Its two brightest stars, Alpha (α) and Beta (β) Cassiopeiae, on the right of the W, point to **M52** [17], a rich star cluster with more than a hundred members. In binoculars, M52 appears as an elongated misty patch with an 8th-magnitude orange star at one edge. The other members shine much fainter and require a telescope to be resolved.

Near Alpha Cassiopeiae lies a showpiece double star, **Eta** (η) **Cassiopeiae** [18]. Small telescopes divide it into yellow and orange components of magnitudes 3.5 and 7.5. **Iota** (ι) **Cassiopeiae** [19] is a slightly fainter

Ian Ridpath *has been touring the sky with telescopes for many years. He is the editor of* Norton's Star Atlas *(Prentice-Hall, 2003).*

pair of white stars, but it is still within easy range of small telescopes. A 4-inch shows that the brighter star is also a close pair, turning this into an impressive triple.

Next to Cassiopeia is Cepheus, with some classic objects, most famously **Delta** (δ) **Cephei** [20], the prototype of the stars used to measure distances to nearby galaxies. Delta Cephei is a cream-colored supergiant whose cyclical fluctuations every 5.4 days are easy to follow in binoculars. At maximum magnitude, 3.5, it shines twice as bright as its faintest, magnitude 4.4. Delta Cephei is also an attractive double star with a 6th-magnitude bluish companion visible in binoculars (although it takes a telescope to see their contrasting colors).

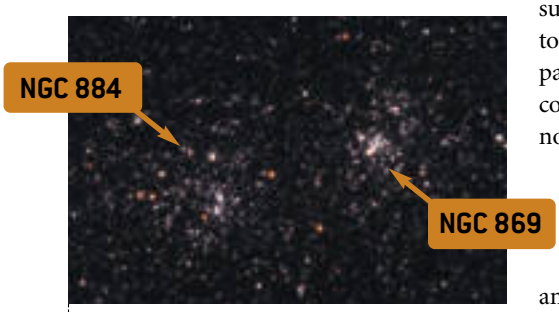
Look also at **Mu** (μ) **Cephei** [21], which William Herschel called the Garnet Star for its ruddy tint, noticeable even in binoculars. A red supergiant, Mu Cephei is a type of pulsating star whose variations repeat from cycle to cycle only approximately. At brightest, which occurs about every two years, it reaches magnitude 3.4, but at minimum, it shines at magnitude 5.1.

Another celebrated variable here is Algol, **Beta** (β) **Persei** [22]. This is the prototype of an eclipsing binary system in which one star periodically passes in front of a close companion, dimming their combined light. In the case of Algol, which normally shines at magnitude 2.1, the eclipses occur every 2.87 days, reducing the star's light to one-third its usual value for 10 hours before returning to normal.

Between Perseus and Cassiopeia lies a pair of open clusters called **NGC 869** and **NGC 884** [23], or the Double Cluster. To the naked eye, they appear as a brighter piece of the Milky Way, while binoculars show each about the apparent size of a Full Moon. They lie side by side about 7,000 light-years away in a nearby spiral arm of our galaxy. Their brightest members are powerful giants and supergiants. NGC 869 (the one closer to Cassiopeia) is the more densely packed of the two, whereas NGC 884 contains some red giants, whose color is noticeable through small telescopes.

Finally, note the scattering of stars around **Alpha** (α) **Persei** [24], which lies 600 light-years away. These stars form a particularly large, loose cluster, an attractive sight with the naked eye and binoculars — and a memorable way to end this tour of the fall sky. ▲

CEPHEUS THE KING lies in the Milky Way near Cassiopeia. It is home to two interesting stars on this tour — and it offers pretty star fields to sweep through using binoculars. BILL AND SALLY FLETCHER



THE DOUBLE CLUSTER (NGCs 869 and 884) lies between Perseus and Cassiopeia. This pair of open clusters stands out nicely against the Milky Way. With a telescope, look for delicately colored stars in the two clusters. JERRY LODRIGUSS

TRICKY TO SPOT, the Helix Nebula (NGC 7293) is half as big across as the Full Moon — but a whole lot fainter! Pick a moonless night and get away from artificial lighting. Use binoculars or a low-power telescope to find it. ADAM BLOCK/NOAO/AURA/NSF

For a few deep-sky "challenge" objects, see www.astronomy.com/toc

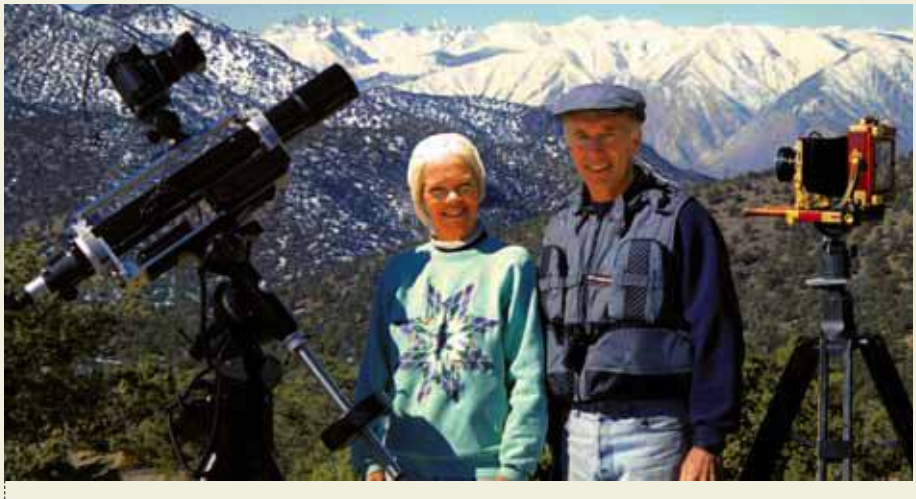
For two decades, a pair of astrophotographers has produced some of the finest images of deep-sky objects and constellations. /// TEXT AND PHOTOS BY BILL AND SALLY FLETCHER

Shooting the sky

A sunny spring day in 1983 found us driving down Interstate 405 in California in our red Volkswagen convertible with the top down. The reason passersby were giving us "double takes" was the new 16-inch f/4.5 Newtonian telescope that was wedged into the small back seat and protruding another 4 feet out of the car. We had no idea that day what a long and wonderful winding road lay ahead of us.

Buying your first telescope, and learning to use it, is unforgettable fun, and as far as we're concerned, in astronomy the fun never ends. We spent most of our evenings in the first few months with our new "light bucket," as large Newtonians are called, out in our driveway. We were learning the constellations and finding the dim, deep-sky objects that would reveal themselves in the not-too-dark but fairly steady skies at the Pacific Ocean end of the Santa Monica Mountains in southern California. Then, one day while shopping for an eyepiece, the salesman asked, "Have you been up to Mt. Pinos yet?" We had not, but it sounded like something we'd enjoy, so the next New Moon we pulled into the Mt. Pinos parking lot — 2 hours north of Los Angeles and 8,300 feet (2,530 meters) above sea level — to join a couple hundred other amateur astronomers. That was our first star party weekend, and we enjoyed it under the awesome canopy of the summer Milky Way.

It wasn't long before we were photographing through the telescope with a small group of regulars up on the mountain. Learning to record the minute and elusive details of distant nebulae, galaxies, and star clusters on film from dusk to dawn in sub-freezing temperatures is very rewarding and exciting — but it also takes a lot of effort.



BILL AND SALLY FLETCHER stand in front of the White Mountains of California, their second-favorite observing site. To the left is their "constellation-shooting" setup, which is a Losmandy mount with a guide scope. At right is their Pentax 6x7 camera piggybacked with an SBIG ST-4 autoguider.

THE BRIGHT STARS OF GEMINI THE TWINS are easy to see in this image, made with a Pentax 6x7 camera, a 90mm lens at f/5.6, and Kodak 400 PPF film.

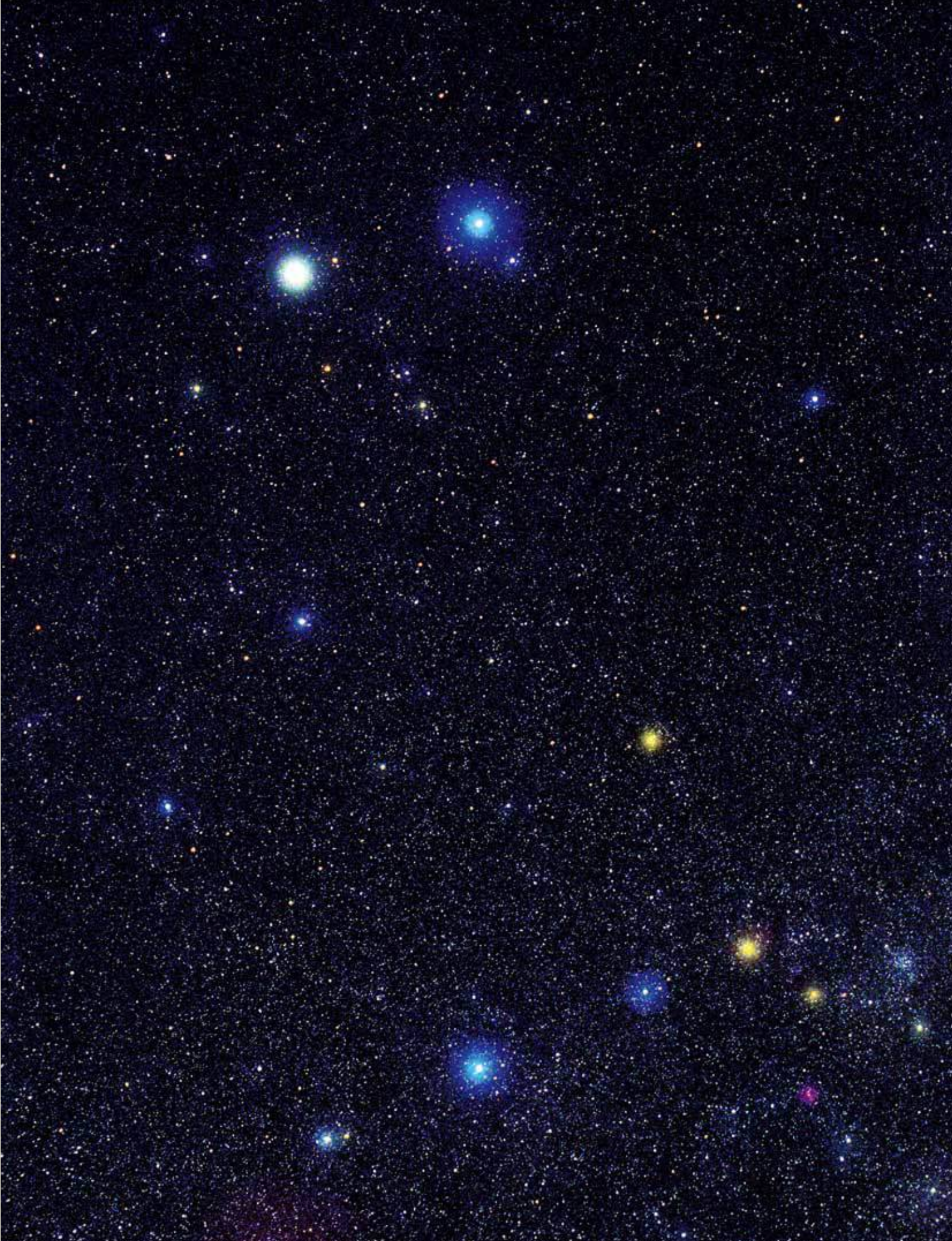
The memory of that era is mostly a blur now. We are reminded of it, however, when we glance over the 192 photo-log sheets from our astrophotography weekends. We spent thousands of inspiring hours allowing our telescopes to bask in photons sent from beautiful celestial objects whose light ended its journey at Earth.

Our process

We started our astrophotography using Kodak 2415 Technical Pan film, which still is the best film available for black-and-white photos. 2415 has to be hypersensitized (baked at a low temperature in forming gas, a mixture of nitrogen and hydrogen) for several days to achieve enough speed (so the emulsion builds up an image more quickly) to be useful in astronomy. With its high contrast and micron-sized grain, this excellent film allowed us to create beautiful images on the nights we got the guiding and focus right.

By the early 1990s, we had honed our skills considerably, refigured our optics, upgraded the mount and drive equipment, and were ready for a new challenge. We decided to find a way to make perfect color images by utilizing a system of photography called "tri-color." This involves taking separate exposures through red, green, and blue filters and then combining them into a single image. Professional astrophotographer David Malin had been doing tri-color in Australia with professional telescopes and a very extensive and expensive photo lab. We felt it had to be possible to utilize our smaller, portable equipment and Tech Pan film to achieve good results also.

Producing high-quality negatives with this system was long and careful work, but



that wasn't the hardest part. Assembling the three black-and-white images into a single color image was a lot more difficult than we expected. We tried to accomplish this in our darkroom for at least a year but were never happy with the results. Finally, Apple came out with the Quadra line of computers, which had enough computing power to turn version 2 of *Photoshop* into a digital darkroom. This, too, was a slow process because computers at that time were much slower than those today, but it got the job done.

Our first tri-color shot was the Dumbbell Nebula (M27). It was bright and therefore easy to shoot, and we knew it had lots of color. But all the subtle and different colors we'd never seen before in this object surprised us. Our enthusiasm was higher than ever, and with a few adjustments to our procedures, we started shooting all the objects we could in tri-color. The Andromeda Galaxy (M31) revealed a yellow-orange core with lots of blue in the outer arms. The Trifid Nebula (M20) had a wreath of blue nebulosity surrounding it. And the lacey detail that we had seen only in black-and-white photos of the Veil Nebula (NGC 6992-5) showed itself in brilliant color with very little grain — even on large prints.

We are still avid emulsion photographers and use this same basic process today. We shoot an object three times on Tech Pan black-and-white film. Typical exposure times for photographic tri-color images with a fast (low focal-ratio) telescope are 65 minutes through the red filter, 95 minutes through the green filter, and 125 minutes through the blue filter. Once these negatives are developed, they are scanned (digitized) and the red, green, and blue filtration colors are reintroduced as each negative gets assigned to either the red, green, or blue color channels of the software. At this point, it's interesting to examine the negatives. Each looks very different from the other two because each has recorded only information from one color.

We found it was important to take plenty of time with the computer portion of image processing. One of the best tips we can pass on is to work on several different

Bill and Sally Fletcher *are longtime astrophotographers who operate Science & Art Products, an on-line astronomy store, from Malibu, California.*

THE TRIFID NEBULA (M20) is an example of a combination reflection nebula (the blue areas) and emission nebula (the red areas). The Fletchers took this tri-color image through their 16-inch Newtonian reflector at f/4.5.

THIS 16-INCH F/4.5 NEWTONIAN REFLECTOR on a homemade mount is the telescope the Fletchers use to image deep-sky objects.

AN 8-INCH F/1.5 SCHMIDT CAMERA, used for wide-field imaging, sits atop the Fletchers' custom-built equatorial mount.

THE WITCH HEAD NEBULA (IC 2118) is a large, beautiful reflection nebula located in the constellation Eridanus the River. The nebula has a blue color because it is reflecting and scattering light from the brilliant, nearby star Rigel (left). The authors took this tri-color image on Kodak Technical Pan film with an 8-inch Newtonian reflector at f/4.5.

THIS MILKY WAY PANORAMA was assembled from four wide-field photographs taken through the authors' Pentax 6x7 medium-format camera equipped with a 55mm lens on Kodak Pro 400 PPF film. Scorpius the Scorpion lies near the right edge, and Cassiopeia the Queen is the constellation at the left edge. The reddish North America Nebula (NGC 7000) in Cygnus lies a quarter of the way in from the right edge.

days. This will keep your eyes "honest" and keep the images looking photographic and true. One must be patient with the many details involved in creating photographically fine images.

We eventually added an 8-inch f/4.5 Newtonian to capture wider views of the sky and then an 8-inch f/1.5 Schmidt camera, which turned out to be a great tri-color instrument. Our Schmidt camera has enough aperture to record fine detail, yet it still shoots a 7° field. We now can photograph the Orion and Horsehead nebulae together, the entire Veil Nebula, the Rho Ophiuchi complex and, of course, comets. For comets, however, we use regular color film because they are moving too quickly for our tri-color process.

Shooting constellations

By the late 1990s, we wanted to try something new again. We started experimenting with a medium-format camera and various defocusing techniques to try getting photos of constellations that were not only beautiful, but useful when giving talks about the night sky. We wanted to show not just the deep-sky objects within the constellations, but also the colors and shapes of the bright star asterisms. It took a year or so to come up with a system that gives us complete control over the final photograph.

The main component of this system is a diffusing filter that is applied for only a portion of the exposure. It works essentially like a cloud that comes in and scatters the light of just the brightest stars. The filter doesn't affect the sharpness of the dim stars and deep-sky objects in the photo. We now have shot virtually all the constellations in the Northern Hemisphere and look forward to trekking Down Under to shoot the Southern Hemisphere. While we're in Australia we can finish our mosaic of the Milky Way, which so far includes the galactic center region of Scorpius and Sagittarius and continues out past Cassiopeia and the Andromeda Galaxy.

This avocation now has filled two decades of our lives. We've learned a lot about astronomy and have been thrilled many times by the perspective of small sentient creatures peering out into the universe, understanding at least some portion of what we're seeing. I guess that sounds a little "grand," but at those moments, the view takes your breath away!

COMET HYAKUTAKE passed closest to Earth in 1996. The authors took this tri-color image with an 8-inch Newtonian reflector at f/4.5 using Kodak Technical Pan film.

SPIRAL GALAXY NGC 253 lies 25 million light-years away in Sculptor. The Fletchers created this tri-color image with their 16-inch Newtonian reflector at f/4.5 using Kodak Technical Pan film.

THE RHO OPHIUCHI REGION is one of the most colorful in the sky. The bright yellow star at the bottom right of this photograph is Antares, which is lighting up the surrounding region with a yellow-orange glow. The star Rho Ophiuchi is responsible for the blue-violet color. The dark streamers are dust and dark gas. The tightly packed cluster of stars is globular star cluster M4. This tri-color image was taken through the authors' 8-inch Schmidt camera at f/1.5 on Kodak Technical Pan film.

THE BRIGHT STARS OF SAGITTARIUS THE ARCHER resemble a teapot. Several of the many deep-sky objects that lie within Sagittarius are visible in this tri-color image, taken through the Fletchers' 16-inch Newtonian reflector at f/4.5 using Kodak Technical Pan film.

Find out how the Oregon Star Party of 1988 — with about a dozen attendees — evolved into one of today's most well-attended star parties in the country. /// TOM POLAKIS

The Oregon Star Party

The popularity of large star parties is soaring. Many of them are now household names. Florida's Winter Star Party, in the Florida Keys, provides welcome relief from the cold of winter. The Texas Star Party, held in the arid hills of west Texas, is now a 25-year-old institution, and the emerging Nebraska Star Party is coming into its own as a centrally placed summer astronomy destination. Among these great astronomy venues, there's still one that attracts more people and offers seeing conditions that rival any in the country, yet it's nearly unknown outside the Pacific Northwest. Thanks to a crew of dedicated volunteers, the Oregon Star Party (OSP) exemplifies how a large star party *should* work.

Like any star party, the Oregon Star Party has humble origins. In 1988, OSP cofounder and current director Chuck Dethloff led a dozen intrepid members of Portland's Rose City Astronomers 8 hours to a site tucked in the southeast corner of Oregon. The parched Steens Mountain site can be found in the blackest patch of the light-pollution map of the United States (see "Reclaim the night sky," June 2004). By the fourth year at Steens, attendance had soared to more than one hundred visitors, but many of the travelers were not fond of the long drive and unforgiving nature of this extremely remote location. Today, Steens Mountain remains the site of an annual pilgrimage for the most dedicated Rose City Astronomers, but the OSP profits from a more accessible location at Indian Trail Spring in the Ochoco Mountains in the center of the state.

The site

Credit for the discovery of the current OSP site goes to Gary and Carolyn Strong. The Strongs once held a streak of 55 consecutive weekends of camping. The Ochocos were a familiar place for them — one they knew had great potential for observing. During a long hike, they came to a majestic Ponderosa pine tree overlooking a vast, treeless area — the new and current home for the OSP.

THIS REMOTE DIRT ROAD leads to some of the darkest sky in the country — and one of the best-kept secrets in star parties. RON FORRESTER

This site represents everything desirable in an ideal observing site. The elevation of 5,000 feet (1,524m) provides great transparency and keeps observers nested high above the immediate surroundings. This elevation also minimizes katabatic (downward) wind that ruins local seeing conditions at many sites in the western states. It also has the underappreciated benefit of creating a low horizon. Extremely finicky observers snipe about the tiny light domes of nearby Prineville and Bend visible on the western horizon, but 95 percent of the sky is "true dark," a darkness not to be bested on Earth. And there is an abundance of space to set up, even for the more than nine hundred attendees at OSP 2003.

During the 3 days of OSP, the patch of National Forest in the Ochocos converts to a small, bustling city. For a small fee, registrants receive passes to enjoy the service of a shower truck. Until the early morning hours, hungry observers can feast on treats — such as star burgers — at the concession stand. And because this is the Northwest, you can expect the espresso tent to be running at all hours. The 2003 star party introduced a new feature to OSP: satellite Internet service. Terminals set up in a trailer from NomadISP enabled attendees to access their e-mail and download the latest in weather forecasts. At any time during the star party, dozens of people throughout the observing fields were accessing the satellite feed wirelessly.

The people of OSP

These days, a dark location is — out of necessity — very remote. So running a star party in the middle of nowhere requires herculean effort. More than twenty organizers, mostly Rose City Astronomers, meet each month, with activity becoming increasingly hectic as the star-party dates approach. The committee was recognizable at the 2003 OSP as the people with the walkie-talkies and tie-dyed shirts.

The star party director, Dethloff, always has his fingers on the pulse of the event. His easy-going demeanor and uncanny sense of what's right for the star party is prerequisite for such a demanding job. His responsibilities as director range from establishing a laser-pointer policy to negotiating allowable attendance with the Forest Service to maintaining the audio-visual equipment. When the weather turns

MORE THAN NINE HUNDRED PEOPLE attended the Oregon Star Party in 2003. BRUCE JOHNSON **WITH JUST TWENTY ATTENDEES,** (inset) the second Oregon Star Party nearly doubled in size from the previous year. The original site of the OSP — tucked away in southeastern Oregon's Steens Mountain — remains a rewarding expedition for any adventurous observer. BRUCE JOHNSON

OREGON STAR PARTY DIRECTOR Chuck Dethloff shows off an innovative front-surface mirror-cooling fan during the telescope walkabout. TOM POLAKIS

OBSERVERS HUDDLE around an Internet-equipped laptop computer for the latest satellite images of the evening weather. BERNIE SANDEN

DAN GRAY (in black shirt) assembles his 28-inch string telescope in front of a group of onlookers. This impressive, practical design introduces lightweight setup to a large aperture telescope. Gray's telescope is just one of many examples of homemade equipment on display and in use at OSP. TOM POLAKIS

bad — as it did during a violent thunderstorm in 1993 — Dethloff must play the role of counselor to the saddened party attendees and organizers.

Dethloff works closely with his indefatigable wife, Judy — the codirector and treasurer of the star-party committee. Probably no more thankless job than registrant exists; Susie McClain fulfills this role exceptionally, despite the many last-minute requests. Cofounder Candace Pratt books the guest speakers. With a nod to the Texas Star Party, Pratt acknowledges that the OSP speaker program may not be "world-class," but she points out that plenty of high-quality speakers reside in the Northwest. Other volunteers work in the registration tent, coordinate door prizes, and put together observer packets. All of them also can be found observing late into the night, leaving one to wonder what it's like not to sleep.

During OSP 2003, it was nice to see the emphasis on observing during the daytime presentations. Veteran observer Howard Banich gave a comprehensive summary of observing Mars, which came to opposition only one day before the 2003 star party officially began. Dave Haworth's talk about imaging bright objects with digital cameras was as visually appealing as it was interesting. For those with an interest in non-electronic observing, Howard Knytych discussed star-hopping. Former *Astronomy* editor Richard Berry's talk gave a three-dimensional perspective on the Milky Way. And legendary astronomer Allan Sandage's son Dave spoke about the history of Mount Wilson Observatory, which is located just outside Los Angeles.

Innovation in homebuilt equipment abounds at the OSP. In contrast to holding a competition for amateur telescope making, Mel Bartels runs a "telescope walkabout" of the field's most interesting telescopes each year. Each scope-maker speaks about his or her creation's good and bad points without fear of judgment. Bruce Sayre, a practitioner of the hobby for more than 50 years, used Computer Aided Design software to build a behemoth, 22-inch binocular telescope. Dan Gray had the audacity to set up a 28-inch telescope in front of more than one hundred people. Using three trusses and a framework of six cables, his "string telescope" is a practical innovation that introduces lightweight and easy setup to a large aperture. Bartels even showed off features of his 20-inch scope, including the "flex rocker" bearing design that lowers the telescope's profile and a wire secondary-mirror support. The entire telescope weighs 85 pounds, 50 of which is the mirror.

IN SUMMER 2003, the B&B Complex fire burned 90,769 acres of the Deschutes National Forest, 14 miles west of Bend, Oregon. Despite the blanket of smoke, OSP attendees still enjoyed personal-best views of Mars.

NASA/JACQUES DESCLOITRES/MODIS RAPID RESPONSE TEAM/GSFC

Tom Polakis *lives in Arizona, where he is an aerospace engineer by day and a deep-sky observer and astrophotographer by night.*

A walk around the observing fields reveals a lot about who attends the Oregon Star Party. Ninety percent are from either Oregon or Washington. John McGarvey, a member of both the Boeing Employees Astronomy Club and the Seattle Astronomical Society, was trying out his new 14-inch Starmaster Dobsonian, which gave a pleasing view of star cluster NGC 7789. Across the field, Rick Olson of the Rose City Astronomers — a repeat attendee, with six other OSP trips under his belt — swept up Uranus. Clearly one of the best scopes on the field belonged to Tom Osypowski: a 24-inch Dobsonian that is driven, of course, because his company produces tracking platforms.

A breakdown of OSP 2003 attendees reveals more than two hundred of them to be under the age of 20 — an encouraging sign in an increasingly graying hobby. Jenny Forrester helped the cause with the many youth activities she led. Devoting hundreds of hours beforehand, Forrester kept the kids engaged and productive throughout the course of the star party. During the daytime hours, they built 4-inch scopes, held a kids-versus-adults astronomy quiz, and launched water bottle rockets. On soil that looked uncannily like Mars, Rob Brown emceed the popular Mars Rover race. And Bob McGown used a meteorite hunt to educate kids on these rocky visitors from outer space.

ON YOUR MARS! GET SET! ROVE! During the 2003 OSP, children had a chance to race remote-controlled Mars rovers. TOM POLAKIS

The 2003 party

Thursday evening began under the characteristically clear summer sky of central Oregon, but trouble loomed on the western horizon. Unfortunately, an all-too-common forest fire raging in the Cascades poured smoke over the site, slowly degrading transparency during the evening. Indeed, smoke has become more of a nuisance than clouds during western summers. But in the Northwest, you take what you can get during the short observing season, so we all kept on observing.

On Friday, the setting Sun was safe to look at directly through a wall of smoke — never a good sign for a star party. After one shift in the wind, the sky cleared, allowing the site to show off all that is visible under superb conditions. Both the Dumbbell Nebula and M81 were naked-eye targets to practiced observers. The Milky Way through Cygnus was broken up into knots of faint stars, but Sagittarius was a bit low for this Arizonan's tastes.

Saturday showed promise early, but the sky again came under a pall of smoke. While the smoke was at its thickest, the seeing settled down to sub-arcsecond quality, demonstrating that when high-altitude currents are not present, not much air stirs near ground level at this excellent site. Folks enjoyed their best views of Mars — one of them through David Brooks's 25-inch Newtonian reflector fitted with a binoviewer. Tanked up with snack-bar refreshments and caffeine, it was easy to stay up and take full advantage of these seeing conditions.

While Indian Trail Spring was plagued by smoke during the 2003 star party, it remains one of the country's premiere observing sites. The daytime activities that are the product of tireless volunteers will make the Oregon Star Party an annual event on my calendar, so mark it on yours, too. See you there!

ALL'S QUIET ON THE WESTERN FRONT as telescopes and their owners rest during the day. If you attend the Oregon Star Party, be sure to prepare for hot days and cool nights. TOM POLAKIS

Learn star-party survival tips at www.astronomy.com/toc

EQUIPMENT REVIEW

A new digital camera delivers high-resolution, deep-sky photographs for a fraction of the cost of a CCD camera. /// TEXT BY MARK HANSON AND R. A. GREINER, IMAGES BY MARK HANSON

Canon 10D digital camera

Until recently, the highest quality astroimaging by amateurs was done universally with high-priced CCD cameras. These cameras, containing cooled, monochrome CCD chips, cost thousands of dollars. To create a color image with one of these CCD cameras, three or more images must be taken through different color filters.

The images are then combined to create a composite color image. Using CCD cameras requires considerable patience, practice, and skill. The resulting images from these cameras, however, are excellent, and many have been reproduced in the pages of *Astronomy*.

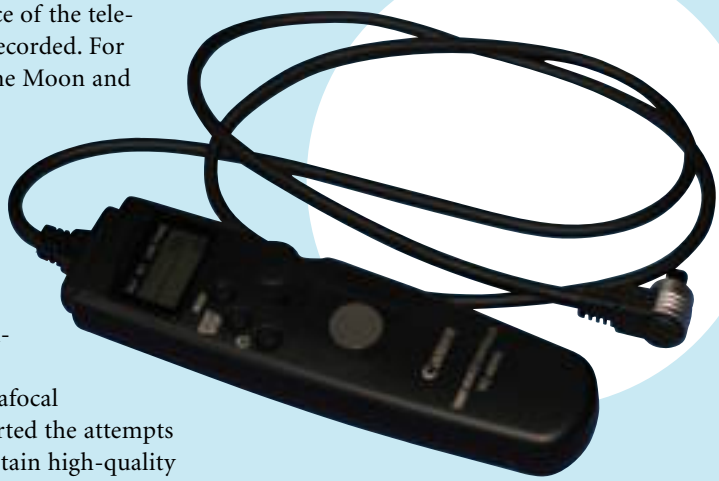
Single-exposure color images of celestial objects also have been taken for some time with point-and-shoot digital cameras. These cameras have been used in the "afocal" mode, which means they are pointed into the eyepiece of the telescope and an image is recorded. For bright objects such as the Moon and planets, this technique has yielded images of acceptable quality. Most deep-sky objects are dim, however. Thus, the low sensitivity of point-and-shoot cameras combined with the complex optical arrangement of afocal photography have thwarted the attempts of many amateurs to obtain high-quality images of deep-sky objects.

THE RUNNING MAN NEBULA (NGC 1977) (6-inch Takahashi FCT-150 apochromatic refractor at f/5, fifteen 4-minute exposures with a camera setting of ISO 800, taken January 18, 2004, from the New Mexico Skies astronomy resort)

Enter the 10D

A few professional digital single-lens reflex (SLR) cameras became available in the late 1990s. These allowed deep-sky photography, but their cost has put them out of reach for most amateurs. In the past 2 years, more affordable SLR digital cameras have become available. One of the best is the newest of the Canon line of digital SLR cameras, the 10D, which incorporates a color CCD chip with 6 million pixels (6 megapixels).

For astroimaging, the Canon 10D competes with CCD cameras. Still, significant challenges exist. The electronic noise level of current SLR digital cameras is not as low as it is in cooled CCD cameras, but other advantages far outweigh this problem. Digital SLRs can generate a full-color image with each exposure. They have a large chip with megapixels of resolution. And the imaging techniques are similar to those used for 35mm film astrophotography, which are well known to many amateur astronomers. Also, unlike a point-and-shoot digital camera, an SLR digital camera can be used at the prime focus of the telescope. This allows the primary telescope optics to be used to full advantage.



THE CANON REMOTE TIMER, used for multiple long-duration exposures, is a must-have accessory. It controls the number of exposures, their length, and the intervals between them. The remote timer makes long sequences of exposures automatic.

Pros and cons

Author Mark Hanson took all the images in this article with a Canon 10D. A comparison between a CCD camera's technical specifications and the 10D's shows the strengths of each. The 10D has a large chip, 22.7mm by 15.1mm with 6.3 megapixels. A typical CCD camera has a chip 13.8mm by 9.2mm with 1.5

THE CANON 10D with a 50mm lens attached is well-suited for wide-field pictures of the Milky Way.

THE LCD READOUT on the Canon 10D shows, at a glance, which settings are being used and allows for several adjustments of the camera.

MANY TELESCOPE ADAPTERS are available to attach the Canon 10D to virtually any telescope. This Takahashi telescope adapter often is attached to Hanson's 10D.

THE LAGOON NEBULA (M8) IN SAGITTARIUS (6-inch Takahashi FCT-150 apochromatic refractor at f/5, ten 5-minute exposures with a camera setting of ISO 800, taken July 1, 2003, from the New Mexico Skies astronomy resort). All images were taken in RAW mode and converted using *Image Plus* into 16-bit TIFF files. They were then calibrated, aligned, and adaptive combined, and the contrast was slightly increased using the *digital development* function in *Image Plus*. A mask was applied to the nebula region (to isolate it) and the contrast of the rest of the image was raised again using the *background stretch* function. This image was then combined with the original image to bring out more of the nebula without stretching the entire background.

megapixels. The advantage goes to the digital camera with a factor of 2.7 times the imaging area. The cost of the 10D — approximately a quarter that of a typical CCD camera — also must be considered an advantage. Ease of use also tips toward the 10D. The raw images from both cameras need a significant amount of post-processing in order to yield excellent final images. In most cases, the same processing software is used, so neither camera has an advantage in this case. Also a draw is the hookup factor — how easy it is to attach each camera to the telescope. Most CCD camera heads are slightly lighter than the 10D body, but they also have cords connected to them. The 10D is a self-contained unit. Mounting the 10D on a telescope is easy because standard, commonly available camera adapters are used to couple the camera's body to the telescope's focuser.

The major disadvantage of current digital cameras is their noise performance, which is poorer than that of CCD astrocameras. A CCD camera usually is cooled to as low as –30° C because the dark (electronic) noise in the chip declines by a factor of two for each 6° to 8° C drop in temperature. Digital cameras cannot easily be cooled below

THE BACK PANEL of the Canon 10D incorporates a large LCD screen and all the controls necessary to access the camera's wide variety of features.

/// PRODUCT SPECS

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Monitor: 1.8-inch color LCD monitor

Flash: Built-in

Pixels: Approximately 6.3 megapixels (3,088 by 2,056)

Price: $1,329 (street price)

Contact information

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[w] www.usa.canon.com

Mark Hanson *is a committed digital astrophotographer who enjoys the challenges the hobby demands.* **R. A. Greiner** *is a retired professor of Electrical and Computer Engineering.*

THE WHIRLPOOL GALAXY (M51) IN CANES VENATICI (12-inch Meade LX200 Schmidt-Cassegrain telescope at f/10, seven 2-minute exposures at ISO 400 plus seven 2-minute exposures at ISO 800 plus nine 2-minute exposures at ISO 1600, taken April 1, 2003, from the New Mexico Skies astronomy resort). In this image, author Mark Hanson first used *Image Plus*'s *color balance* function to adjust the color and accentuate the dust lanes between the galaxies. Next, an adaptive smoothing slightly blurred the image. The background then was darkened using the *background contrast* function. Hanson also used dark line enhancement as well as a multi-resolution sharpening to reveal the dark lanes in the galaxies.

0° C because they are not designed for extreme cold.

Auxiliary equipment required for using a digital camera is similar to that required for a CCD camera. For the 10D, Hanson has a right angle finder scope for coarse focusing and the Canon remote control timer accessory (TC80N3) for hands-off operation. The TC80N3 allows Hanson to take any number of exposures in sequence with any exposure time and any interval between exposures.

For imaging, Hanson pairs his 10D to one of three telescopes: a 12-inch Meade LX200 Schmidt-Cassegrain telescope; a 4-inch Takahashi FSQ-106 refractor; or a 6-inch Takahashi FCT-150 refractor. The 3000mm focal length of the LX200 telescope is great for smaller deep-sky objects, and the Takahashi telescopes are perfect for wide-field imaging. Whatever telescope you choose, the Canon 10D will connect to it easily. You'll find the 10D easy to use, and the images you'll produce with it will delight you. ▲

GALAXIES M81 AND M82 IN URSA MAJOR (6-inch Takahashi FCT-150 apochromatic refractor at f/7, twenty-one 4-minute exposures with a camera setting of ISO 1600, taken January 19, 2004, from the New Mexico Skies astronomy resort)

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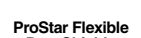

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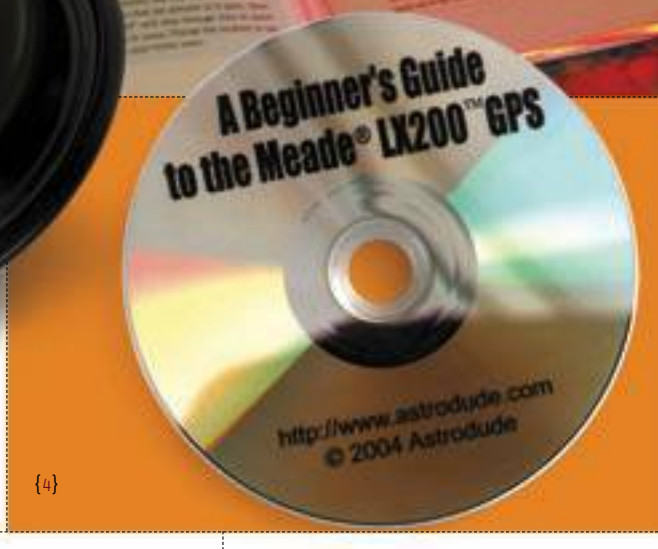

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4. Astrodude's instructional DVD
Astrodude, a.k.a. Patrick Harrold, is still going strong. He's produced a 90-minute video discussing all the steps necessary to get your Meade LX200GPS Schmidt-Cassegrain telescope out of the box and under the stars. Sections include setting up and running in alt-azimuth or equatorial mode. A detailed section on the Autostar II hand controller shows the many options it provides.

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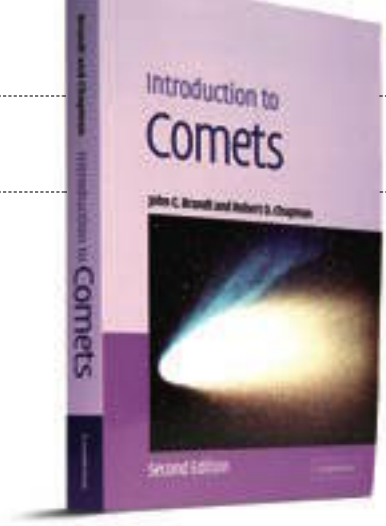
Getting to grips with comets



Introduction to Comets, 2nd edition

John C. Brandt and Robert D. Chapman, 441 pages, Cambridge University Press, New York, 2004; ISBN 0–521–00466–7; paperback, $60.

In the preface to the first edition of *Introduction to Comets* (1981), Brandt and Chapman say that comets "are not presently topics of widespread interest in the astronomical community." But they expected the situation would likely change over the course of the next few decades.

As a result of the return of Halley's Comet in the mid-1980s, the appearances of bright comets Hyakutake and Hale-Bopp in the mid-1990s, and the dramatic collision of Comet Shoemaker-Levy 9 with Jupiter in 1994, the authors' prediction has strikingly come true. Nothing illustrates this growth of knowledge more dramatically than a page count of the two editions. The 2nd edition runs more than 75 percent longer than the first.

Introduction to Comets provides a detailed discussion of almost every aspect of cometary phenomena. These include the chemical make-up of comet nuclei; their comae and tails; the physical processes that produce the features we see; the interaction of comets with the solar wind; the origin and fate of comets; the relationships between comets, asteroids, meteor streams, and meteorites; and comets' role in the formation of the solar system as well as their impact threat for Earth.

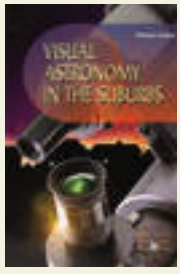
I would have liked more details on some topics, but if the authors had attempted to please everyone, the book would be prohibitively large. While the coverage seemed a bit uneven, overall, I think the authors have struck a reasonable balance of subjects.

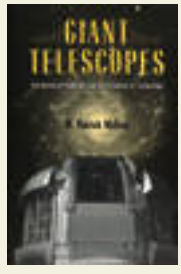
The book aims to be suitable for advanced undergraduate and graduate students. I concur with this. While I would hesitate to recommend this book to the average layperson, anyone seriously interested in comets should get it. The scientific concepts and math will be accessible to advanced undergraduate science majors with some knowledge of calculus. The book is lavishly illustrated, and while some are "pretty pictures," many of the illustrations help explain the scientific concepts. Finally, readers who wish to pursue any topic in greater detail will find an extensive bibliography to get them going.

I found a couple annoying editorial glitches. These include references to nonexistent sections and at least one place where text was apparently lifted from the first edition without change. Some illustrations taken from scientific papers suffer from poor reproduction and are hard to read. I hope these issues can be taken care of in subsequent printings. I'd also recommend adding a glossary to explain scientific terms that are introduced, in some instances without being fully defined.

It's perhaps unfortunate that the second edition is coming out now, just prior to the new scientific results we can expect from the current crop of spacecraft missions (which are discussed in Chapter 11) and from the bright comets that are in the sky as I'm writing this review.

But that's the hazard of writing any book in a field evolving as rapidly as cometary science. In any case, I certainly hope the authors produce a third edition in the not-too-distant future — at least sooner than the two-plus decades that elapsed between the first edition and this one! **— ALAN HALE,** *a comet scientist and long-time observer, codiscovered Comet Hale-Bopp. He is developing Earthrise, an educational and humanitarian project.*





Visual Astronomy in the Suburbs

Anthony Cooke, 265 pages, Springer, New York, 2003; ISBN 1–85233–707–9; paperback, $39.95.

Every backyard skygazer cherishes skies so dark they look deep, deep gray due to unresolved, faint starlight. But the reality for most of us is a suburban site full of compromises. California amateur astronomer Anthony Cooke has written a valuable book that accepts these limitations and shows how you can explore the heavens from home. And his tour isn't limited to just the Sun, Moon, and planets, either. He dives into the deep-sky realm using large telescopes, filters, and an image intensifier to boost the brightness of faint galaxies, nebulae, and star clusters.

Giant Telescopes

W. Patrick McCray, 367 pages, Harvard University Press, Cambridge, Massachusetts, 2004; ISBN 0–67401147–3; hardcover, $45.

Astronomy rides on its light grasp, which is why astronomers are never satisfied with existing instruments. McCray tells the story — as full of politics as science — behind the building of the two 8-meter Gemini Telescopes, one on Mauna Kea in Hawaii and the other on Cerro Pachón in Chile. A theme that runs throughout is how new technology brings new knowledge of the universe. McCray also underscores the importance of governmental funding, without which big telescopes (in fact, most of astronomy) would quickly cease.

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Venus transit tours
Astronomy editor Dave Eicher and associate editor Michael Bakich ventured to Egypt and South Africa, respectively, to view the transit of Venus. Read their travel accounts from these two very different locations on the African continent.

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09.09.04–09.12.04

Prairie Skies Star Party

Camp Shaw-Waw-Nas-See, near Kankakee, Illinois. The event is sponsored by the Amateur Astronomy Events and Conventions Association. The bright lights of nearby Chicago will not be a factor. For more information, contact John Weber at 708.481.7970; e-mail, prairieskies@ameritech.net.

09.10.04–09.12.04

Astro-Tour

Balreich Observatory, Tiffin, Ohio. Hosted by the Sandusky Valley Amateur Astronomy Club, this gathering will showcase the 1895 McMillian 12.5-inch refractor. For more information, contact Tom Day at 419.797.4854; web site, *www.friendlynet.com/astronomy*.

09.10.04–09.11.04

White Sands Star Party

White Sands National Monument, near Alamogordo, New Mexico. The purpose of this year's star party is to raise money for the New Mexico regional site for Project ASTRO — an arm of the Astronomical Society of the Pacific that brings

astronomers into the classroom. Registered participants will have special access to keynote speakers, camping privileges, and tours. For more information, visit *www.zianet.com/wssp*.

09.16.04–09.19.04

Amateur Teleskoptreffen "Mirasteilas"

Falera, Graubünden, Switzerland. This event brings together anyone interested in discussing astronomy and observing. For more information, visit *www.mirasteilas.net*.

09.16.04–09.18.04

Astrofest

Vana's Farm, Kankakee, Illinois. Sponsored by the Chicago Astronomical Society, this is the 25th annual gathering. *Astronomy* staff members will attend this star party. For more information, call Walter Glogowski at 847.910.2878; e-mail, casdarksky@ameritech.net; web site, *www.chicagoastro.org*.

09.17.04–09.19.04

Arunah Hill Days

Arunah Hill Natural Science Center, Cummington, Massachusetts. This high-elevation site in western Massachusetts offers great, dark skies. For more information, contact Steve Pielock at 413.374.1627; e-mail, pielock@pielock.com; web site, *www.arunah.org*.

09.17.04–09.18.04

Cathedral Gorge Campout

Cathedral Gorge State Park Campground, Panaca, Nevada. The northern Nevada location won't be affected by the bright lights of Las Vegas's casinos. Besides stargazing, other attractions include fishing, hiking, and tours of a nearby mining ghost town. For more information, contact Geary Keilman at n2422v@aol.com; web site, *www.astronomyvegas.com*.

09.17.04–09.19.04

Great Lakes Star Gaze

River Valley RV Park, near Gladwin, Michigan. This central Michigan location offers the advantage of a dark sky without the necessity of driving to a rural location in the northern part of the state. For more information, contact Joe Bruessow at 989.662.0178; e-mail, jbruessow@chartermi.net; web site, *www.boonhill.net/sunset/stargaze.htm*.

09.17.04–09.19.04

Northern Prairie Starfest

Black Nugget Lake, near Tofield, Alberta, Canada. Besides having a dark sky, the site is located on a major fall migration flyway and offers exceptional birding opportunities. Lakeshore campsites are available for fishing and canoeing. This is one of the northernmost star parties in North America, so spotting an aurora is not an uncommon occurrence. For more information, visit *www.edmontonrasc.com/nps.html*.

09.17.04–09.19.04

Tennessee Star Party

Camp Nakanawa, Crossville, Tennessee. The Barnard-Seyfert Astronomical Society will host this fifth annual event. The site has cabins and camping facilities available. For more information, e-mail, tnsp@bsasnashville.com; web site, *www.bsasnashville.com*.

09.18.04–09.19.04

Whirlpool Star Party

Doolys Hotel, Birr, County Offaly, Ireland. Sponsored by the Shannonside Astronomy Club, this is the 18th annual gathering. Speakers include Michael McKay of the European Space Agency, Stephen Beckwith of the Space Science Telescope Institute, and astronomy author Stephen O'Meara. For more information, visit *www.geocities.com/shannonsideac/speak04.htm*.

CONTACT INFORMATION

Please submit club announcements four months in advance to Coming Events, *Astronomy*, P. O. Box 1612, Waukesha, WI 53187, or jmcgovern@astronomy.com. Also use this e-mail address to submit your events for our on-line calendar.

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RESOURCES

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LISTENING FOR A WHISPER

BOOKS — *Cosmic Company: The Search for Life in the Universe* by Seth Shostak and Alex Barnett (Cambridge University Press, New York, 2003) ponders the possibility of aliens visiting Earth. What would it mean, in the first place, if we were to detect a signal from the cosmos that would prove we're neither alone nor the smartest creatures in the universe?

The SETI Institute has published an excellent book about their search. *SETI 2020: A Roadmap for the Search for Extraterrestrial Intelligence* by Ronald Ekers et al. (SETI Press, Mountain View, California, 2002) is a comprehensive study of how scientists should direct their future efforts.

Sharing the concept of extraterrestrial intelligence with children is made easier with Ellen Jackson's *Looking for Life in the Universe* (Houghton Mifflin, New York, 2002). Questions like "Is there life elsewhere in the universe?" and "What is that life like?" are answered in simple language.

WEB — At the SETI Institute home page, *www.seti.org*, you'll find the latest news, information on projects, educational materials for teachers, and more. If you want to join the search for extraterrestrial life, visit *www.setiathome.ssl.berkeley.edu*.

OUR LOCAL STAR FACTORY

BOOKS — Material on Gould's Belt lies scattered throughout the literature of astronomy. One useful place to start is *The Guide to the Galaxy* by Nigel Henbest and Heather Couper (Cambridge University Press, New York, 1994). David Malin's colorful book, *A View of the Universe* (Cambridge University Press, New York, 1993), has wonderful photos of many areas of the Milky Way that include Belt objects. A chapter by Per Lindblad in *Stars and the Milky Way System*, edited by L. N. Mavridis (Springer-Verlag, New York, 1974), is now 30 years old, but it reviews the observational history of the Belt as astronomers gradually unfolded its nature.

WEB — For a highly useful and interesting guide to Gould's Belt, see both *ottawa.rasc.ca/observers/1999/an9912p8.html* and *ottawa.rasc.ca/observers/2000/an0001p3.html*. To find recent professional work on the topic, search both *arxiv.org* and *adsabs.harvard.edu/abstract_service.html*.

CASSINI SPIES PHOEBE

ARTICLES — For details about Cassini's flyby of Jupiter in late 2000 and early 2001, check out Richard Talcott's "A giant awakens Cassini" (*Astronomy*, April 2001). Also see a story by planetary scientist Alfred S. McEwen, "Journey to Saturn" (*Astronomy*, January 2004). McEwen, a member of the Cassini imaging team, presents the mission's top-ten highlights.

WEB — The official web sites of Cassini and Huygens are the best sources for news on their progress. NASA's site, which focuses on the Cassini orbiter, resides at *saturn.jpl.nasa.gov/index.cfm*. The European Space Agency's site for the Huygens probe is located at *sci.esa.int/science-e/www/area/index.cfm?fareaid=12*.

TREKKING THE AUTUMN SKY

BOOKS — Every deep-sky observer can make use of a star atlas. *Norton's Star Atlas*, edited by Ian Ridpath (Pi Press, New York, 20th edition, 2003), remains a useful field companion for small-telescope users. Going deeper calls for a star atlas that goes fainter, and the popular choice of many observers is Wil Tirion and Roger Sinnott's *Sky Atlas 2000.0* (Cambridge University Press, New York, 2nd edition, 1998). It scores highly for both its portability and comprehensiveness.

WEB — A list of 150 binary stars is at *www.dibonsmith.com/orbits.htm*. For variable stars, check out *www.aavso.org*, which has light curves, finder maps, and more.

SHOOTING THE SKY

BOOKS — Michael Covington's *Astrophotography for the Amateur* (Cambridge University Press, New York, 2nd edition, 1999) is a complete guide to taking pictures of the Sun, Moon, comets, meteors, eclipses, galaxies, and more. Covington discusses choosing cameras and telescopes, and the second edition includes new chapters on CCD imaging.

Another excellent resource for astrophotographers is *Heavenly Bodies: The Photographer's Guide to Astrophotography* by Bert P. Krages (Amherst Media, Buffalo, New York, 2003). Krages shows how all photographers can access astrophotography, and he divides his text nicely between astronomy and photography.

ARTICLES — Some of the best imagers of celestial objects have been featured in *Astronomy*. Jack Newton shares his imaging skills in "Basic CCD techniques" (September 2003). Bob and Janice Fera offer a colorful gallery of sky shots in "A night with the Feras" (November 2003). For advanced tips on CCD imaging as well as some terrific images, see "CCD images at their best" by Tony Hallas (February 2004).

At the other end of the spectrum, read David Healy's revealing article "When astrophotos go bad" (April 2004) for potential mistakes to avoid when you're doing astrophotography.

WEB — If you really like the pictures you see in the story, Bill and Sally Fletcher have them for sale. Visit their colorful site at *www.scienceandart.com/index.htm*.

THE OREGON STAR PARTY

WEB — The official web site of the Oregon Star Party is *www.oregonstarparty.org*. Click on it to find registration forms, maps of the grounds, directions to the Indian Spring Trail site, an overview of the interesting (and oftentimes entertaining) history of the OSP, and a wealth of other important information.

To learn more about the discovery of the Indian Spring Trail site, visit Gary and Carolyn Strong's web site at *www.pacifier.com/~juniper/its.htm*.

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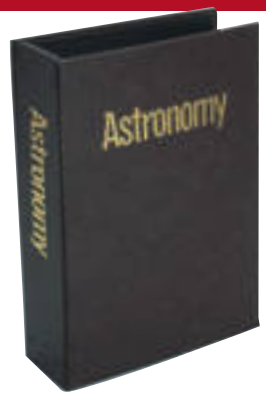

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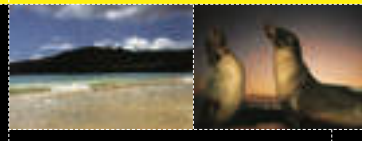

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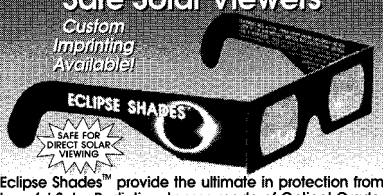

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Astronomy magazine

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Reader gallery

Readers share their images...

Comets C/2001 Q4 (NEAT) and C/2002 T7 (LINEAR) /// The transit of Venus

Q4 PASSES THE BEEHIVE

Objects both near and far

Passing through the spring constellation Cancer the Crab, Comet C/2001 Q4 (NEAT) recently made a spectacular rendezvous with the open star cluster known as the Beehive (M44). Close approaches of one celestial object to another are not rare, but this particular one illustrates the vast distances among objects in space. At the time this digital image was taken, Q4 was approximately 38.8 million miles (62.4 million kilometers) away from Earth. The Beehive, on the other hand, is approximately 580 light-years distant. M44, therefore, was almost 87 million times farther from Earth than Q4 when this image was made.

COMET C/2001 Q4 (NEAT) AND THE BEEHIVE CLUSTER (M44) [Canon 10D digital SLR; Zeiss 180mm f/2.8 Sonnar lens at f/4; Celestron CG-5 driven, equatorial mount; composite of four 2-minute exposures; taken May 14, 2003, starting at 10:00 P.M. CDT from Houston, Minnesota] /// **TOM DIANA**

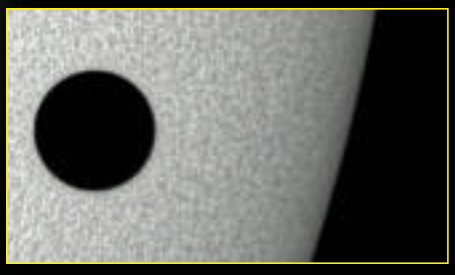
The Venus transit

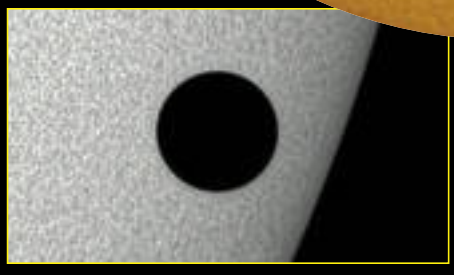
Top, **ITALIAN TRANSIT** (5-inch Pentax 125SDP refractor at f/6.4, Pentax LX camera, Elite Chrome 100 film, DayStar 0.6 Angstrom hydrogen-alpha filter, two exposures — 1/8-second for prominences and 1/30-second for disk detail — stacked, taken from Udine, Italy) /// MARCO COSMACINI AND MARZIA MURADORE

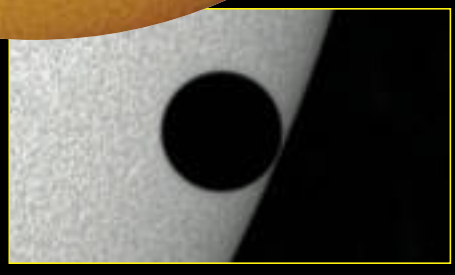
Bottom left, **VENUS'S ATMOSPHERE SEEN AT TRANSIT END** (6-inch Fraunhofer achromatic refractor at f/8, Sony TRV 740E videocamera, taken through green and yellow filters at 11h05m31s UT from Wittem, the Netherlands) /// RALF VANDEBERGH

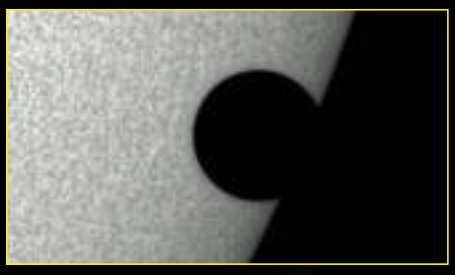
Bottom right, **MID-TRANSIT FROM FRANCE** (Tokura 15x60 terrestrial refractor, Baader Astrosolar filter, Sony DSC-P92 digital camera at f/2.8, 1/125-second exposure at ISO 100, taken 7h23m UT from Champigny sur Marne, France) /// PIERRE JUSTET

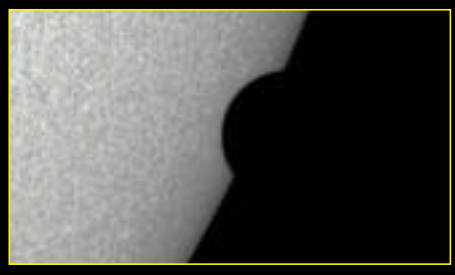
Send your photos to: ASTRONOMY reader gallery, P.O. Box 1612, Waukesha, WI 53187; e-mail to readergallery@astronomy.com.
Please include your full name, date and location of image, and complete photo data: telescope, camera, film, and exposure information.











Upper left, **SUNRISE TRANSIT FROM SOUTH AMERICA** (2.4-inch Bushnell achromatic refractor, Nikon F3 camera body, 1/2000-second exposure on Kodak Pro Image 100 film, taken from Buenos Aires, Argentina) /// MATIAS JONES

Upper right, **A CAPITAL TRANSIT** (Coronado Technology Group MaxScope 90 hydrogen-alpha telescope, Canon EOS Digital Rebel body, 4/10-second exposure taken from Washington, D.C.) /// JACK NEWTON

Bottom, **EGRESS OF VENUS** (6-inch Astro-Physics AP130 refractor at f/6 plus 2x Barlow lens, Vesta Pro webcam, 1/100-second exposures, taken between 10h32m UT and 11h19m UT from Rocchetta, Italy) /// PAOLO LAZZAROTTI

Below, **COMET C/2001 Q4 (NEAT) AND M44** (50mm lens at f/2.8; SBIG ST-2000 XM CCD camera; LRGB image with exposures of 30, 20, 20, and 30 minutes, respectively; taken May 13, 2004, near Benson, Arizona) /// **DEAN SALMAN**

Upper left, **COMET C/2002 T7 (LINEAR)** (Canon T70 camera, Canon 300mm lens at f/5.6, Kodak Max 400 print film, 15-minute exposure, taken May 10, 2004, from Wallsend, New South Wales, Australia) /// **SCOTT ALDER**

Bottom left and right, **TWO VIEWS OF COMET C/2001 Q4 (NEAT)** (*Left*, 300mm Canon lens at f/5.6; *right*, 10-inch Newtonian reflector at f/5.6; both shot through a Canon T70 camera, Kodak Max 400 print film, 15-minute exposures, taken May 10, 2004, from Wallsend, New South Wales, Australia) /// **SCOTT ALDER**

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